RESEARCH ARTICLE

A Critical Analysis of MSME Sector in Jammu and Kashmir, UT

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ABSTRACT

The Union Territory of Jammu and Kashmir conspicuously emerges as the most underdeveloped region within the Indian union with regards to the pivotal facet of industrialisation. Unfortunately, it has proven to be unsuccessful in establishing a presence within the industrial landscape of our nation. Despite the numerous challenges faced in the progression of the Micro, Small, and Medium Enterprises (MSME) sector, there has been a significant upswing observed in this domain within the union territory. Consequently, this development has fostered promising opportunities for lucrative employment within the region. In light of the prevailing unemployment scenario, the objective of this study is to meticulously examine the growth and effectiveness of employment generation facilitated by Micro, Small, and Medium Enterprises (MSMEs) within the region of Jammu and Kashmir. The study utilised the linear regression paradigm to evaluate the impact of micro, small, and medium enterprises (MSMEs) on employment, while considering the incorporation of secondary data sources. The investigation additionally utilised the Shapiro-Wilk test as a means to evaluate the normality of the data. The study's findings indicate that the expansion of the Micro, Small, and Medium Enterprises (MSME) sector has a positive impact on the creation of job opportunities in the Union Territory of Jammu and Kashmir**.**

Keywords: MSMEs, Jammu and Kashmir, Employment, Shapiro-wilk, Growth

INTRODUCTION

The incontrovertible establishment of a correlation between a nation's economic expansion and its level of industrialisation has been duly noted (Dar & Bhat 2013).In the context of highly developed industrialised nations like Japan, Germany, the United Kingdom, and the United States, there exists a widespread recognition of the significant contribution made by micro, small, and medium-sized enterprises (MSMEs) to the broader economic fabric. The

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micro, small, and medium enterprises (MSMEs) are commonly acknowledged as the catalysts driving economic growth in numerous developing nations, with India being no exception. Poverty and unemployment emerge as systemic quandaries in developing nations like India, thereby demanding the augmentation of industrial sectors to provide lucrative employment prospects for the most socioeconomically marginalised segments of society. This would provide them with an opportunity to liberate themselves from the intergenerational cycle of poverty to which they were born. Small and medium-sized enterprises (SMEs) assume a pivotal position within the economy due to their inherent capacity to expeditiously and economically engender significant employment prospects. Micro, Small, and Medium Enterprises (MSMEs) not only serve as a means to address regional disparities and foster a more equitable distribution of national income and resources, but they also play a crucial role in creating substantial employment prospects with a considerably lower investment requirement in comparison to larger corporations. The empirical data indicates that micro, small, and medium-sized enterprises (SMBs) have a significant impact on achieving a range of societal and economic goals. These include the creation of more job opportunities, increased export activities, and the promotion of entrepreneurial initiatives. The veracity of this phenomenon remains consistent across both developed and developing economies, as evidenced by the empirical investigation carried out by Shelly et al. in the year 2020. In the Indian context, it is imperative to acknowledge that enterprises are classified as micro-enterprises when the capital investment in plant and machinery does not surpass the threshold of one crore, and their annual turnover does not exceed the sum of five crores.

Micro-enterprises are defined as enterprises whose investment in plant and machinery does not exceed the threshold of ten crores, and their turnover does not surpass fifty crores. Conversely, it is worth noting that medium-sized enterprises are delineated as entities whose capital expenditure on physical infrastructure and equipment does not surpass the threshold of fifty crores, while their overall revenue does not exceed the limit of two hundred and fifty crores, as per the classification provided by MSME in the year 2020. The sector encompassing micro, small, and medium-sized enterprises (MSMEs) assumes a pivotal role as an indispensable support system for the Indian economy. According to the report on Micro, Small, and Medium Enterprises (MSMEs) published by the Working Group for the 12th Five Year Plan (2012-2017), it is worth mentioning that this specific sector holds considerable significance in the realm of manufacturing production, accounting for a substantial 45% share. Additionally, it plays a pivotal role in the overall exports, contributing a noteworthy 40%. The present count of gainfully employed individuals in the industrial sector stands at around 80 million, encompassing a notable sum of approximately 36 million commercial enterprises, as reported in the comprehensive Working Group Report spanning the years 2012 to 2017. As per the comprehensive findings outlined in the Working Group Report spanning the years 2012 to 2017, it is imperative to acknowledge the remarkable degree of productivity demonstrated by the micro, small, and medium enterprises (MSMEs) operating within the confines of our national boundaries. The small-scale sector plays a crucial role in creating productive job possibilities for millions of people in developing countries like India, which are marked by a surplus of labour but a shortage of capital. It is remarkable that the Indian government has properly incorporated the small and medium business sector into its all-encompassing five-year plans, given the crucial role that SMEs play in the country's economy.

The government places a high priority on the growth of the SME sector, which includes micro, small, and medium-sized businesses. The government's top priority is helping micro, small, and medium-sized businesses (MSMEs) like those involved in the coir and khadi industries and the village industries prosper, as stated in the Ministry of Micro, Small, and Medium-Sized Enterprises' Results-Framework Document (2012-2013). The goal of this effort is to help already existing businesses and encourage the creation of brand new ones by working with the appropriate Ministries/Departments, State Governments, and other stakeholders. Micro, Small, and Medium-Sized Enterprises (MSMEs) in India have been contributing more and more to the country's GDP, as seen by their annual report for the fiscal year 2020-2021. The percentage of GDP contributed by micro, small, and medium-sized enterprises (MSMEs) has been on the rise, from 29.14% in fiscal year 2014-2015 to 30.27% in fiscal year 2018-2019. Micro, small, and medium-sized enterprises (MSMEs) account for 49% of total exports. However, the respected government of India has developed a plan to increase that number to a remarkable 75% (Pwc 2020a, 2020b).Therefore; it can be argued that MSMEs significantly contribute to the nation's social and economic development by acting as supplemental

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entities to bigger firms and performing the roles of auxiliary units. The Union Territory (UT) of Jammu and Kashmir is strategically located in the northernmost part of the Indian union. The geographical area in question proudly showcases a plethora of bountiful natural resources, including but not limited to Gypsum, limestone, coal, lignite, and quartzite. These valuable assets play a substantial role in fostering and enhancing its overall economic well-being. Moreover, in addition to its copious agricultural and horticultural bounties, the locality also showcases extensive tracts of sylvan landscapes. The favourable climatic conditions of the state lend themselves remarkably well to the cultivation of silkworms, an indispensable element in the manufacturing of exquisite silk fabric. The state's extraordinary natural beauty, globally acclaimed havens for rejuvenation, deep-rooted legacy of skilled craftsmanship, and captivating geographical characteristics have conferred upon it a unique and indispensable standing in the domains of tourism and artisanal industries.

It is noteworthy that the state is presently in its nascent phases of industrial advancement and conspicuously trails behind the remainder of the nation in terms of progress in industrialisation, to such an extent that it has been omitted from the comprehensive national industrial map. The unfavourable industrial milieu can be ascribed to a multitude of consequential factors, encompassing an unappealing socio-cultural fabric, insufficient infrastructure and transportation amenities, restricted capital accessibility, a dearth of capital expertise, and political upheaval and unrest prevailing within the jurisdiction. As Butt (2005) posits, the present state of affairs is characterised by a dearth of expansive industrial enterprises. Nevertheless, throughout the preceding two decades, there has been a notable surge in the inception of Micro, Small, and Medium Enterprises (MSMEs). As per the conclusive data of the fiscal year 2020-21, it has come to light that the state has borne witness to the establishment of a substantial number of 709,000 micro, small, and medium enterprises (as reported in the MSMEs Annual Report 2020-21b).The prevailing industrial topography of Jammu and Kashmir (J&K) is predominantly distinguished by the existence of Micro, Small, and Medium Enterprises (MSMEs), which assume a momentous role in propelling industrial and holistic economic advancement within the Union Territory (UT). The Micro, Small, and Medium Enterprises (MSMEs) make a notable contribution of approximately 8% to the overall Gross State Domestic Product (GSDP). These enterprises play a significant role in generating employment opportunities, encompassing both the manufacturing and services sectors, as elucidated in the Industrial Policy of 2021.The state possesses the inherent capacity to furnish propitious circumstances for micro, small, and medium enterprises (MSMEs), contingent upon the allocation of adequate focus and resources towards the advancement of these entrepreneurial ventures.

LITERATURE REVIEW

The exponential growth of small and medium-sized enterprises (SMEs) gives rise to a corresponding augmentation in job prospects, thereby making a valuable contribution towards the alleviation of poverty rates. The scholarly enquiry conducted by Herman (2012) has revealed that small and medium-sized enterprises (SMEs) in Romania demonstrate a greater inclination towards labour absorption when compared to their larger counterparts. The scholarly enquiry undertaken by Kowo, Adenuga, and Sabitu (2019) has revealed a noteworthy association between micro, small, and medium enterprises (MSMEs) and the mitigation of poverty in Nigeria. The correlation at hand can be primarily ascribed to the generation of novel employment opportunities facilitated by these enterprises. The research undertaken by Rotar, Pami, and Bojnec (2019) provides additional insight into the positive correlation that exists between Micro, Small, and Medium Enterprises (MSMEs) and their capacity to assimilate labour. The academic endeavours undertaken by Gebremariam and Gebremedhin in the year 2004, Hamdar, Najjar, and Karameh in 2017, and Manzoor et al. in 2019 have made substantial contributions to the respective field of enquiry.As per the scholarly findings of Ntea et al. (2014), it is an incontrovertible verity that micro, small, and medium enterprises (MSMEs) have consistently played a pivotal role as the bedrock for fostering economic progress and advancement, not solely limited to emerging nations but also encompassing sophisticated economies. Based on the scholarly work of Dey (2014), one can deduce that micro, small, and medium enterprises (MSMEs) exert a nuanced impact on diverse facets of the economy. These enterprises not only make a positive contribution to the Gross Domestic Product (GDP), production output, and employment opportunities, but they also play a vital role in guaranteeing the affordability and accessibility of goods and services within the economy.

Furthermore, it is widely acknowledged that Micro, Small, and Medium Enterprises (MSMEs) possess a propensity for providing ingenious and resourceful resolutions to tackle burgeoning obstacles and cater to the ever-changing demands of the marketplace. In a scholarly enquiry conducted by S. Gade (2018), a comprehensive analysis was undertaken to evaluate the implications of India's micro, small, and medium-sized enterprise (MSME) sector on the nation's holistic development and advancement. Moreover, the aforementioned study has furnished perceptive recommendations with the explicit objective of fortifying the micro, small, and medium enterprises (MSMEs) domain, thereby guaranteeing its enduring contribution to the advancement and progress of the nation. The undeniable significance of small and medium-sized enterprises (SMEs) in augmenting the economic milieu cannot be contested. These enterprises have demonstrated noteworthy progress in the realm of job creation, facilitating the advancement of rural industrialisation, nurturing the entrepreneurial mindset, and alleviating regional imbalances (Bhuyan, 2016). In their scholarly endeavour, Bhat and Yatoo (2019) embarked upon a meticulous analysis of the myriad factors that facilitate or impede the assimilation of cloud computing within the realm of small and medium-sized enterprises (SMEs) situated in the northern region of Jammu and Kashmir, India. The erudite scholars expound upon the notion that micro, small, and medium-sized enterprises (MSMEs) can reap substantial benefits from the integration of cloud computing into their operations. This innovative approach empowers them to effectively harness technological resources, thereby potentially enhancing their prospects for expansion and development. According to the scholarly research conducted by Amir, S. and Iqbal, J. (2019), it is crucial to recognise that the importance of an investment holds no weight unless it undergoes a meticulous and all-encompassing assessment procedure. The erudite scholars undertook an enquiry into the consequences of varied capital budgeting choices on the effectiveness of small and medium-sized enterprises in the region of Jammu and Kashmir.

Bhat and Soni (2015) cogently emphasised the crucial significance attributed to SIDCO in alleviating the state's predicament of unemployment by fostering the establishment of sustainable employment opportunities. These organisations are serving as intermediaries, facilitating communication and coordination between various levels of governance and proprietors operating within the industrial sector. It is imperative to refrain from underestimating the intrinsic worth that industry promotional organisations, such as SIDCO, possess in their capacity to foster and facilitate the expansion of economies. The scholarly research conducted by Arvind Kumar Singh and his colleagues in 2014 delved into the crucial role that entrepreneurs play in promoting the growth and development of micro, small, and medium enterprises (MSMEs). This study shed light on the significant challenges faced by the MSME sector and highlighted the importance of entrepreneurial efforts in overcoming these obstacles. Furthermore, the scholars delved into the noteworthy promotional initiatives undertaken by the Government of India in order to revitalise this particular industry. The scholarly publications authored by Kumar & Kumar (2018) and Rathore and Mathura (2019) provide valuable insights into the intricate and multifaceted complexities encountered by micro, small, and medium enterprises (MSMEs), encompassing a comprehensive range of external and internal dimensions. The foremost challenges faced by micro, small, and medium enterprises (MSMEs) revolve around the domains of finance, production, safety, inadequate working capital, restricted availability of testing infrastructure, scarcity of raw materials, and fierce competition, among various other factors. In light of the aforementioned context, the primary aim of this study is to evaluate the progression and effectiveness of micro, small, and medium enterprises (MSMEs) in terms of their impact on the generation of employment opportunities within the Union Territory of Jammu and Kashmir. The investigation shall encompass a temporal span commencing in 1999 and concluding in 2021. The prevailing body of research pertaining to the expansion and efficacy of Micro, Small, and Medium Enterprises (MSMEs) within the geographical confines of Jammu and Kashmir has predominantly adopted a limited temporal scope. Henceforth, the evaluation of the influence exerted by MSMEs on employment yields an inconclusive outcome owing to the restricted temporal scope of the analysis. Furthermore, barring a select cohort of esteemed scholars, the prevailing body of research predominantly directs its attention towards the evaluation of the formidable obstacles encountered by the Micro, Small, and Medium Enterprises (MSME) sector within the geographical confines of the Jammu and Kashmir region.

OBJECTIVE

The objective of this study is to assess the growth and performance of Micro, Small, and Medium Enterprises (MSMEs) in the union territory of Jammu and Kashmir.

MATERIAL AND METHODS

This study utilises secondary data obtained from a wide range of published and unpublished sources, encompassing the Government of India, the Government of Jammu and Kashmir, and various scholarly articles, among other references. The principal data sources employed in this study encompass the annual reports of the Ministry of Micro, Small, and Medium Enterprises (MSME), the annual reports of the Directorate of Economics and Statistics in Jammu and Kashmir, the Digest of Statistics in Jammu and Kashmir, and the Economic Survey of Jammu and Kashmir. The aforementioned sources offer invaluable time series data, serving as the bedrock of our analysis. Descriptive statistical measures, such as the growth rate, have been utilised to evaluate the progression of micro, small, and medium-sized enterprises (MSMEs) and the subsequent generation of employment over different time periods. The application of the basic regression model has been utilised to evaluate the impact of micro, small, and medium enterprises (MSMEs) on employment, wherein MSMEs are considered as the independent variable and employment as the dependent variable. The utilisation of the Shapiro-Wilk test has been employed as a means to evaluate the conformity of the data to a Gaussian distribution. The investigation into the concept of normality and, in a broader sense, the evaluation of assumptions regarding the distribution, has been a substantial area of continuous statistical enquiry (Shapiro & M.B., 1965).Through the utilisation of the Shapiro-Wilk test, an individual shall be able to discern an outcome comprising a statistical measure and a probability value. If the p-value surpasses the conventional threshold of 0.05, one can deduce that the data aligns with the principle of normality, as hypothesised by Shapiro and M.B in 1965[b]

RESULTS AND DISCUSSION

Growth rate
Table 1 illustrates the growth rate of Micro, Small, and Medium Enterprises (MSMEs) and the corresponding employment generation in the state of Jammu and Kashmir (J&K).The growth rate has been determined using the following formula

G =b2-b1/b1

Where G =Growth rate
b2= Current years MSMEs or employment, b1= previous year MSMEs or employment
The table 1 depicts the phenomenon of employment generation within the Micro, Small, and Medium Enterprises (MSMEs) sector in the esteemed union territory of Jammu and Kashmir. Upon careful examination of the information depicted in table1, a discernible pattern emerges, revealing that the temporal interval spanning from 2003 to 2004 showcases a noteworthy surge in the production of job opportunities facilitated by Micro, Small, and Medium Enterprises (MSMEs). The employment generation by Micro, Small, and Medium Enterprises (MSMEs) in the region of Jammu and Kashmir experienced a noticeable decrease during the timeframe of 2018-19. This decline can be primarily attributed to the existing state of political instability within the region. The fiscal period of 2020-21 has witnessed a noticeable decrease in the ability of Micro, Small, and Medium Enterprises (MSMEs) to create job prospects, a phenomenon primarily ascribed to the unparalleled global health crisis referred to as the Covid-19 pandemic. In the aforementioned temporal epoch, it is of considerable import to acknowledge the conspicuous escalation in the unemployment rate of the nation, predominantly ascribed to the rigors prophylactic and curbing measures instituted by the Indian government in response to the epidemic (Shameem, S., & Rajeswari, M., 2022)

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Regression Model

A linear regression model has been utilised to examine the impact of Micro, Small, and Medium Enterprises (MSMEs) on employment. In this analysis, employment is considered the dependent variable, while MSMEs are treated as the independent variable. Nevertheless, it is worth noting that the Shipro-Wilk test has been utilised as a means of evaluating the suitability of the linear regression model for the provided dataset. From the table 2, it becomes evident that the calculated p-values surpass the critical threshold of 0.05 for both instances being analysed. Henceforth, it is justifiable to posit that the dispersion of the dates conforms to a normal distribution. Therefore, the application of the linear regression model becomes viable. The formulation of the linear regression model is undertaken with the purpose of elucidating the fluctuation of the dependent variable, which pertains to employment, in relation to its covariance with the independent variable, specifically Micro, Small, and Medium Enterprises (MSMEs).

$$Y_i = \beta_0 + \beta_1 X_i + \acute{\epsilon}$$

Y_i =Dependent variable (Employment), X_i=Independent variable (MSMEs) .$\acute{\epsilon}$= Random error term
β_0 =Model parameter (intercept), β_1= Model parameter (coefficient)

Upon careful examination of the data presented in table 3, one can discern that the R-square value manifests itself at an impressive magnitude of 0.829. This observation indicates that the independent variable, specifically MSMEs (Micro, Small, and Medium Enterprises), exhibits a remarkable 82.9% influence on the dependent variable, which relates to the aspect of employment. Moreover, after conducting a meticulous analysis, it becomes evident that the computed p-value is recorded as 0.003, a significantly smaller value compared to the customary threshold of 0.05(Table3). As a result, we can assert with confidence that a significant and meaningful correlation can be established between the dependent variable, which is Employment, and the independent variable, referred to as MSMEs. The results provided in table 4, one can discern that the model's coefficient value manifests itself as 4.007. This suggests that a marginal increase in the independent variable, specifically MSMEs, will result in a proportional change of 4.007 units in the dependent variable, namely Employment. Furthermore, it is imperative to acknowledge that the coefficient magnitude demonstrates a favourable inclination, thus indicating a direct association between Micro, Small, and Medium Enterprises (MSMEs) and the phenomenon of employment.

CONCLUSION

The Indian economy has experienced a discernible surge in the importance ascribed to micro, small, and medium-sized enterprises (MSMEs) as a catalyst for both innovation and the creation of novel employment prospects. It functions as the quintessential tool for enhancing economic expansion and fortifying manufacturing efficiency. This study effectively elucidates the significant and positive impact of the proliferation of micro, small, and medium enterprises (MSMEs) on the mitigation of the unemployment rate within the Jammu & Kashmir Union Territory (UT). It is worth noting that despite the UT's primary representation of India's small-scale industrial activity geographically, the findings highlight the favourable outcomes resulting from the growth of MSMEs in addressing unemployment challenges. Despite facing various obstacles, the micro, small, and medium enterprises (MSME) sector in the state is displaying a praiseworthy trajectory of expansion, consequently exerting a positive impact on both the state's unemployed population and the overall economy. It is of utmost importance for the Jammu and Kashmir Directorate of Industries and Commerce, SIDCO SICOOP, and JKEDI to adopt a proactive approach in actively involving the younger demographic of the region. It is of utmost importance that both the state and federal government partake in a synergistic endeavour to propel the state's burgeoning industrial sector towards a more sophisticated and prosperous state. The prompt and efficient advancement of infrastructure development in the region is of utmost importance, as significant investments in micro, small, and medium-sized enterprises (MSMEs) represent a viable avenue for nurturing the expansion and progress of the state's industrial sector. The efficacious execution of policies and initiatives intended to cultivate the expansion of Micro, Small, and Medium Enterprises

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(MSMEs) within a jurisdiction mandates a synergistic endeavour from the federal and regional authorities. The provision of collective assistance is of utmost importance in order to effectively facilitate the growth and progression of these enterprises, thereby making a significant contribution to the overall economic advancement of the region. The progression of micro, small, and medium-sized enterprises (MSMEs) within the state calls for a synergistic intervention from both the federal and state authorities. If duly nurtured, the micro, small and medium-sized enterprise (MSME) sector within the state harbours the potential to engender gainful employment prospects for a significant segment of the jobless populace within the region. As the rapid growth of this specific industry unfolds, it is expected that a corresponding decrease in the unemployment rate will occur, thereby mitigating the primary cause of apprehension within the Jammu and Kashmir administrative region.

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Table 1: Total number of MSMEs and Employment generation

Year	No. of MSMEs units	Growth rate (%)	Employment	Growth rate %
1999-2000	40615	-	180309	-
2000-2001	41435	2.0	183842	1.96
2001-2002	42286	2.1	189708	3.19
2003-2004	44184	4.5	199549	5.19

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2004-2005	45304	2.5	205289	2.88
2005-2006	46685	3.0	215000	4.73
2006-2007	47868	2.5	221761	3.14
2007-2008	48894	2.1	228638	3.10
2008-2009	48768	-0.3	233938	2.32
2009-2010	51027	4.6	241376	3.18
2010-2011	51935	1.8	247099	2.37
2011 -2012	53083	2.2	255866	3.55
2012 -2013	54073	1.9	262448	2.57
2013-2014	54972	1.7	269150	2.55
2014-2015	56063	2.0	271780	0.98
2015-2016	56814	1.3	277870	2.24
2016-2017	57418	1.1	283148	1.90
2017-2018	58072	1.2	289821	2.36
2018-2019	32459	-44.1	200549	-30.80
2019-2020	32766	0.9	204062	1.75
2020- 2021	32726	-0.1	178579	-12.49

Source: Digest of Statistics J&K (2020-21, 2021-2022; Authors Calculation

Table 2 Test of normality

Shapiro-wilk			
	Statistic	**Df**	**Sig.**
No. of MSMEs	.922	21	.096
Employment	.939	21	.208

Table 3 Regression Model

Model	Sum of Squares	Df	Mean square	F	Sig.	R- Sq.	Adjusted R square
Regression	21300694133.376	1	21300694133.376	79.870	0.003[b]	0.829	0.798
Residual	5067154025.862.	19	266692317.151				
Total	26367848159.238	20					

Dependent: Employment

Table 4 Coefficients

Model	Coefficient	Standard error	T	Sig.
No. of MSME units	4.007	0.499	8.937	0.002
Constant	40072.583	21599.939	1.855	0.000

Predictor (constant): No. of MSME units

RESEARCH ARTICLE

Alleviation of Salinity Stress with the Application of Vermi compost on Osmolytes and Enzyme Activities of *Arachis hypogaea* L.

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ABSTRACT

The present study was made to the effect of different concentrations of sodium chloride (NaCl) with the application of vermincompost on germination and biochemical constituents of *Arachis hypogaea* L. The germination study were conducted with various concentrations of NaCl (mM) with vermincompost (%) (0, 10, 25, 50, 10mM+5%, 25mM+10%, 50mM+25% and 100%Vermi compost) and the data were assessed 25th day after germination. The accumulation of proline and glycine betaine content increased at extreme level of 50mM NaCl+ 25%VC. In 100% vermin compost all parameters increased moderately as compare to control. The enzyme activities like catalase, peroxidase and ascorbate peroxidase drastically decreased upto 50mM NaCl and gradually increased in addition with vermicompost. The maximum enzyme activities shown at 50mM NaCl+ 25 % Vermicompost.

Keywords: *Arachis hypogaea* L., Salinity, vermicompost, asmolytes., enzyme activities.

INTRODUCTION

One of the biotic stressors which adversely affects plant growth and development in their natural habitats is soil salinity. The excretion of salt can occur as a result of natural or manmade processes that lead to the irrigation of soil water, which in turn results in an accumulation of salt and disturbs its general growth and development. The total area in the world is 397 million hectares, which includes 19.5% of irrigation lands with salinity and 2.0% of dry areas are exposed to salinity [1]. The Vermicompost is the organic fertilizer made from earthworm droppings that have

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been crushed. They say the plants are very good at absorbing nutrients. In addition, vermicompost has been shown to reduce adverse effects of salt stress on different crops in a number of studies [2].Vermicomposting, which is used for the biotransformation of different waste streams that serve as pollution storage facilities, is an emerging eco-friendly technology. Nitrogen rich organic compost that can improve plant health and fertility is produced from solid soil waste of certain earthworms eg, *Eisenia foetida* sp. Thus, problems such as safe disposal of organic waste, increasing crop production and maintaining food security can be solved by green vermicomposting technology. This has resulted in the development and use of organic products, such as organic fertilisers, green manure mixtures, combinations of fertilizers used for crop rotation, vegetable residues, straw or animal waste with more complex forms like biodegradants, vermicompost, earthworm humus. The use of which has increased, as it contributes to the creation and development of sustainable agriculture [3]; [4]; [5]. One of the key environmental challenges for agricultural production across the world is salinity. In plants, salt stress is characterized by two primary types of physiological stress. In particular, NaCl increases can lead to reduction in the availability of groundwater for plant irrigation due to an increase in internal osmolotic potential according to [6]. Second, due to increased uptake of toxic ions such as Na^+ and reduced uptake of essential elements such as K^+ [7] and P [6], increased NaCl may cause ionic stress. The necessity of maintaining water conditions with osmotic adaptation, allowing maintenance of the turgor while maintaining K^+ Na^+ and stoichiometric selectivity is therefore directly responsible for plant tolerance to salt stress [8].

One of the important cultivation practices is to use soil conditioners with organic fertilizer properties in order to mitigate the adverse effects of salinity on plant growth. By increasing the concentration of micronutrients [9]; [10] and soil macronutrients and improving their structure, organic matter contributes to soil fertility and quality, according to [2]. Proline, which can be found mostly on higher plants, is the most basic of all osmolytes. It is an amino acid and normally rigid, so it has a crucial role to play in response to different algal stresses by means of adaptation, signals and recovery mechanisms. Proline accumulation has been shown to enhance stress tolerance in plants, which may be increased by proline accumulation at chloroplast and cytoplasm level as well as when plant is subjected to strain [11]. In the study of tolerance to plant stress, proline accumulation is a major indicator. Plants accumulation of proline with NaCl salinity has also been observed in several other plants, and proline accumulation may also contribute to non-enzymatic detoxification of free radicals [12].Concentrations of glycine betaine significantly increased under salt stress in mung bean cultivars [13]. A derivative of methyl glycine, the quaternary ammonium compound GB N,N,N, trimethylglycine is also called parent betaine. The most widely grown in GBs is betaine, which has been produced by desiccation as a result of different biological stress factors including drought, salinity and temperature extremes [14]. Glycine betaine, a major complementary compound which is in Poaceae and Chenopodiaceae species under different salinity levels has been shown to participate in multiple defense mechanisms against stress related plant diseases [15]; [16]. GB is an amphoteric metabolite that is highly soluble in water and is electrically neutral in a wide pH range [17]. By controlling ion channels, enhancing plasma membrane H^+-ATPase enzyme activity, improving phosphate absorption, and regulating phosphate homeostasis, GB can decrease salt-induced potassium influx[18]; [19]. When GB and proline are present in high concentrations, plants are protected from oxidative stress so well that antioxidant metabolites and enzymes are not as important in salinity-related ROS defense [20]; [21]; [22].

Through a wide range of mechanisms and functions, plant antioxidants contribute significantly to the development of plants. Plants have a number of antioxidant enzymes that are associated with ROS scavenging, and exposure to oxidative stress is known to increase the synthesis of these enzymes. The ROS are made up of free radicals including superoxide radicals (O_2), hydroxyl radicals (OH), perhydroxyl radicals (HO_2), and alkoxy radicals as well as non-radical forms like hydrogen peroxide (H_2O_2) and singlet oxygen ($^1O_2$) that are found both within and outside of the plant's cells. A single electron transfer from dioxygen (O_2) to superoxide radicals (O_2) can produce superoxide radicals [23]. Mainly, these plant enzymes are superoxide dismutase (SOD), catalase (CAT), peroxidase (POX), glutathione peroxidase (GPX), glutathione reductase (GR), glutathione S-transferases (GST), ascorbate peroxidase (APX), monodehydroascorbate reductase (MDHAR), and dehydroascorbate reductase (DHAR), which work as part of the antioxidant defence system. The plant has antioxidant defence systems consisting of enzymatic and not enzymatic components that hold the ROS balance in a cell under stress. For example, they activate superoxide

dismutase (SOD) and catalase (CAT) enzymes for sweeping different types of ROS. However, depending on the duration and severity of the salt stress, the effect of salt stress on plants varies, according to [24]. The potential of vermicompost fertilisers for improving soil physical and chemical conditions as well as its role in mitigating the damage caused by salt stress to plant growth. In salt stress, the use of vermicompost increases the activity of the antioxidant enzymes in the plant [25]; [26]. Therefore, using vermicompost may be an effective method to mitigate the adverse effects resulting from excessive Na^+ and Cl^- levels on soils in order to enhance their antioxidants and chlorophyll content.

MATERIALS AND METHODS

Experimental Studies
Arachis hypogaea L. seeds were collected from Seed Research Institute, Aduthurai and this seeds were surface sterilized with 1% sodium hypochloride for five minutes. Then washed with tap water thrice used as a germination studies. The seeds were germinated with various concentration of NaCl (0,10,25 and 50mM) and also application of vermicompost (10mM+5%, 25mM+10%, 50mM+25% and only 100% vermicompost). The seeds could not survive above 50mM NaCl. Five seedlings of each replicate was selected for recorded morphological parameter on 25th day after sowing. The fresh weight of the seedlings were separated and weighed electronic balance. The separated plants organs were kept in hot air oven at 80^0 C for 24 hours and then weighed in electronic balance. The leaf area was calculated by measuring the length, width and number of leaves and multiplied by correlation factor (0.66) and derived from the method of Yoshida et al., 1972.

Osmolytes
Based on the method of [27], proline has been obtained and estimated. According to the methodology of [28], these samples have been collected and estimated. Statistically, the method of a Complete Randomised Block Design with ANOVA one way method was used to analyse this data.

Enzyme Activity
The protocol outlined by [29] was followed in order to estimate the catalase activity. The [30] protocol was followed when performing the peroxidase activity. The method outlined by [31], was followed in order to estimate the ascorbate peroxidase activity. Complete randomised block design was used to statistically analyse the data (ANOVA one-way method).

RESULTS AND CONCLUSION

Germination percentage, Length of seedlings, fresh weight and dry weight
The highest germination percentage was observed in control plant (95%) and in salinity treatment the maximum germination was observed in the optimum level of 50mM NaCl and combined with application of vermicompost 50mM NaCl + 25% VC was higher when compared to control. The highest values was recorded in 50mM NaCl (60%) and 50mM NaCl + 25% VC (90%) when compared to control (Table 1). In the course of drought, salt and heat stress conditions, Vermicompost preparation increased seed germination in both seed sets [32]. The data on the effect of salinity and application with vermicompost on the seedling shoot length and root length (14.9 g plant^{-1}; 12.4 g plant^{-1}) on 50mM+25% VC when compared to control. The similar trend was observed in fresh weight and dry weight also and their was observed in (11.4 g plant^{-1}; 10.38 g plant^{-1}) and (10.5 g plant^{-1}; 9.5 g plant^{-1}) when compared to control (Table 2). A study has shown that the use of VL improved root development, total leaf area, leaf count and stem thickness when exposed to NaCl induced salt stress by increasing tomato seed growth. In this respect, it has been reported that the application of leaves to pomegranate seed, when treated with NaCl, has reduced the Na content and also reduced the degradation of chlorophyll and oxidative stress, suggesting that it has an effect on reducing salt stress, VL [33].

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Proline

The results on the accumulatioin of proline content increased with increasing concentrations up to 50mM NaCl and 50mM NaCl + 25% vermicompost and this was recorded in leaf, stem and root (9.541, 7.102 and 4.4 mg g^{-1} fr. wt.) and (13.104,10.891 and 7.159 mg g^{-1} fr. wt.) .when compared to control (Fig. 1). In saline environments, plants produce more proline [34], yet using more vermicompost makes it harder for plants to cope with NaCl stress [35] .

Glycinebetaine

When compared to control on the 25th day after treatment, the accumulation of glycinebetaine content increased with extreme levels of 50mM NaCl salinity and 50mM NaCl + 25% vermicompost (4.207, 3.104, and 2.33 mg g-1 fr. wt. and 5.3991, 4.856, and 3.889 mg g-1 fr. wt., respectively) (Fig. 2). Glycine betaine is widely involved in increasing plant resistance under various environmental stresses, including salinity and drought [36]. In addition with vermicompost also increase in the glycine betaine content [37].

Enzyme Activities

Catalase

The result on the catalase activity decreased in increasing salinity up to 50mM NaCl level and gradually increase with increasing in addition of vermicompost. Maximum increase in catalase activity was recorded in 50mM NaCl + 25% vermicompost (3.94 unit min^{-1} mg protein) when compared to control. It was also recorded that in 100% vermicompost catalase activity was moderately higher than control (3.23 unit min^{-1} mg protein) (Fig. 3). In a study, SOD and CAT activities significantly increased in tandem with the rise in salt levels, enabling the plant to withstand salt stress. When compared to control plants (non-VC), the VC treated plants were observed to have considerable SOD and CAT activities that actively participate in the sweep of ROS [24]; [25].

Peroxidase

The results on the peroxidise activity decreased with increasing concentrations up to 50mM NaCl and gradually increased in addition with vermicompost. Maximum increase in the peroxidase activity was recored in 50mM NaCl+25% vermicompost (5.391 unit min^{-1} mg protein) when compared to control on 25th day after treatment. The extreme level of 100% vermicompost peroxidae activity was moderately higher than control (5.211 unit min^{-1} mg protein) (Fig.4). According to the results of an analysis of variance, the simple effects of salinity and vermicompost stress on the activity of antioxidant enzymes were significant; additionally, the interaction effects of treatments on catalase, superoxide dismutase, ascorbate peroxidase, and glutathione peroxidase were significant, but the interaction of these two factors with malondialdehyde was not significant [26].

Ascorbate Peroxidase

The data on the ascorbate peroxidase activity of various concentration of salinity with combined vermicompost are given in fig.5. The result on ascorbate peroxidase decreased in increasing salinity up to 50mM NaCl level and gradually increase with increasing in addition of vermicompost. Maximum increase in as corbate peroxidase activity was recorded in 50mM NaCl + 25% vermicompost (43.568 unit min^{-1} mg protein) when compared to control. At extreme level of 100% vermicompost ascorbate peroxidase activity was moderately higher than control (39.11 unit min^{-1} mg^{-1} protein). [38] Assessed the impact of salinity and vermicompost supplementation on levels of antioxidant enzymes activity in photosynthetic pigments. The findings of an analysis of variance show that salt stress and vermicompost significantly altered the amounts of ascorbate peroxidase, catalase, Glutathione peroxidase, Superoxide, dismutases or total chlorophyll enzymatic reactions.

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Table 1. Effect of NaCl in addition with vermicompost on germination percentage of *Arachis hypogaea* L. at 25 DAS. Values are mean and standard error of five replicate.

Concentration	No. Of seed	Germination of seed	Germination (%)
Control	20	18	90
10 mM	20	16	80
25 mM	20	15	75
50 mM	20	12	60
10 mM + 5%	20	13	65
25 mM + 10%	20	14	70
50 mM + 25%	20	19	95
100%	20	17	85

Table 2. Effect of NaCl in addition with vermicompost on growth parameter of *Arachis hypogaea* L. at 25 DAS. Values are mean and standard error of five replicate.

Concentrations	Growth Parameter (cm plant^{-1})		Fresh Weight (g plant^{-1})		Dry Weight		Leaf Area
	Shoot Length	Root Length	Shoot	Root	Shoot	Root	
Control	8.42±0.421	11.9± 0.595	7.96± 0.398	2.76± 0.138	5.63±0.282	1.23±0.062	4.2±0.210
10	11.2± 0.56	9.86± 0.493	9.19±0.459	5.05± 0.2525	7.1±0.355	3.4±017	3.46±0.173
25	10.4± 0.52	10.8± 0.54	10.36±0.518	6.4± 0.32	9.7±0.485	3.2±0.16	3.32±0.166
50	9.16±0.458	9.27± 0.463	12.5± 0.625	5.83± 0.2915	10.5±0.525	4±0.2	3.08±0.154
10mM+5%	5.62±0.281	5.76± 0.288	7.13± 0.357	4.71± 0.2355	5.4± 0.27	3.9±0.195	3.22±0.161
25mM+10%	10.3± 0.515	7.53± 0.377	11.8± 0.59	8.17± 0.4085	9.5±0.475	5.7±0.285	3.91±0.196
50mM+25%	14.9± 0.745	12.4± 0.62	11.4± 0.57	10.3± 0.515	10.5± 0.525	9.2±0.46	4.27±0.212
100%v.c	14.3± 0.715	11.9± 0.56	11.2± 0.56	9.14± 0.457	9.2± 0.46	7.8±0.39	4.11±0.206
F	64.939*	61.149*	8904.174*	12504.836*	1641.678*	11079.025*	237.667**

* The F values were significant at 1% level.

** The F values were significant at 5% level.
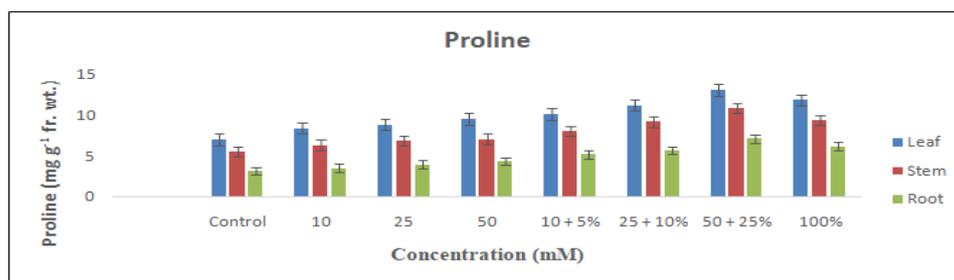
The F values were significant at 1% level.
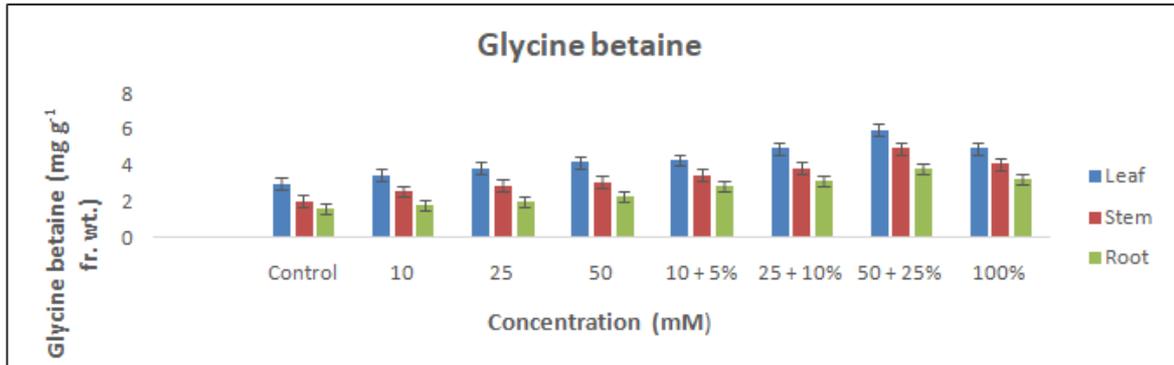Leaf – 349017.637*
Stem – 633892.642*
Root – 35285.59*

Figure 1. Effect of NaCl in addition with vermicompost on proline (mg g^{-1}fr. wt.) of *Arachis hypogaea* L. at 25 DAS. Values are mean and Standard Error of five replicate.
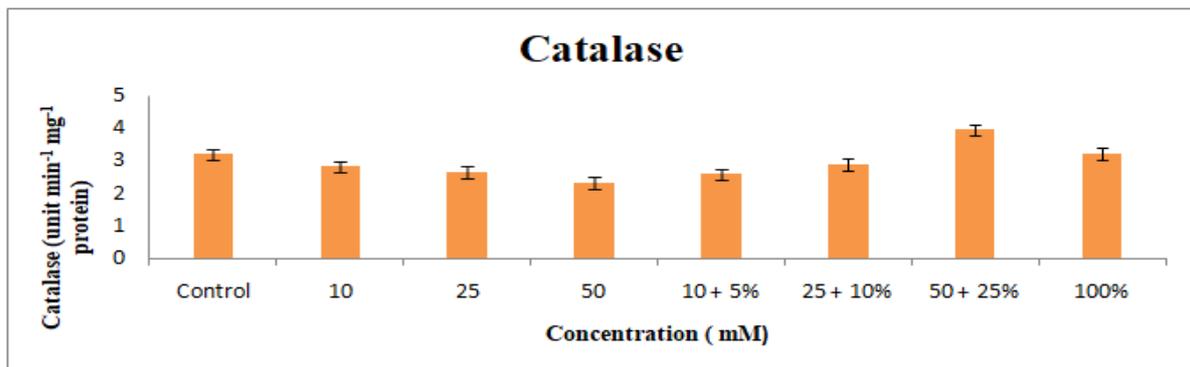
The F values were significant at 1% level.

Leaf –111329.381*
Stem – 122100.379*
Root – 59302.597*

Figure 2. Effect of NaCl in addition with vermicompost on glycinebetaine (mgg⁻¹fr. wt.) of *Arachis hypogaea* L. at 25 DAS. Values are mean and Standard Error of five replicate.
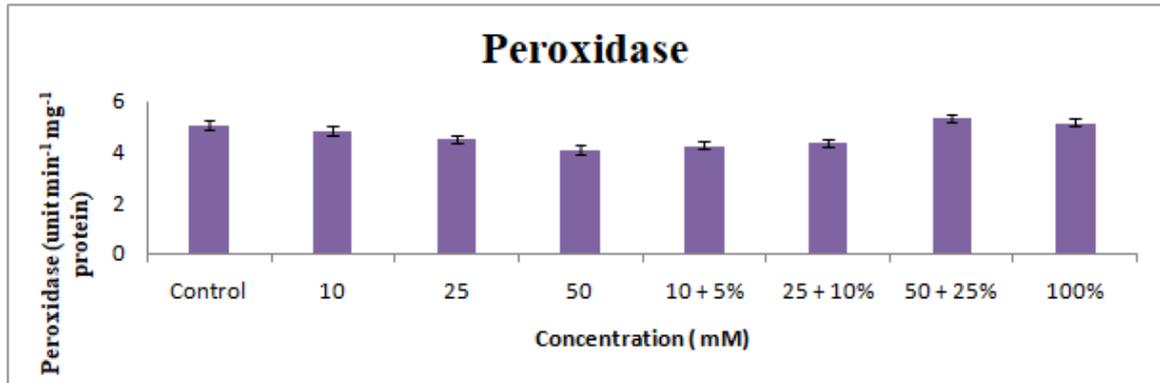

The F values were significant at 1% level: 6654.238*

Figure 3. Effect of NaCl in addition with vermicompost on Catalase (unit min⁻¹ mg⁻¹ protein) of *Arachis hypogaea* L. at 25 DAS. Values are mean and Standard Error of five replicate.
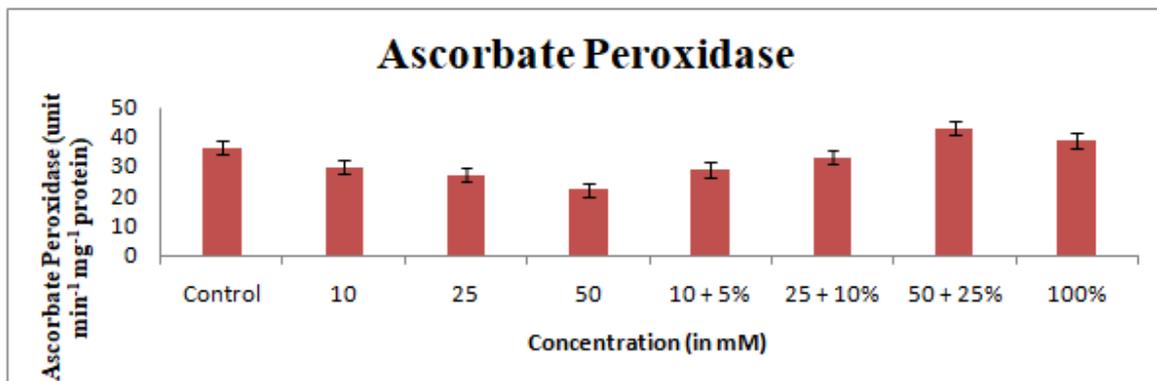
The F values were significant at 1% level: 12805.689*

Figure 4. Effect of NaCl in addition with vermicompost on peroxidase (unit min⁻¹ mg⁻¹ protein) of *Arachis hypogaea* L. at 25 DAS. Values are mean and Standard Error of five replicate.

The F values were significant at 1% level: 498455.946*

Figure 5. Effect of NaCl in addition with vermicompost on Ascorbate Peroxidase (unit min⁻¹ mg⁻¹ protein) of *Arachis hypogaea* L. at 25 DAS. Values are mean and Standard Error of five replicate.

RESEARCH ARTICLE

An Analysis of the Shear Bond Strength of Orthodontic Brackets Bonded with Color-Changing Adhesives and the Conventional Light Cure Adhesive: An *In vitro* Study

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ABSTRACT

To Evaluate and Compare the shear bond strength of Orthodontic Metal brackets bonded with color-changing adhesive with a conventional light-cure adhesive. In this investigation, 150 permanent premolar teeth that had been extracted intact were employed. Before bonding, fluoride varnish was administered to every tooth sample, and bracket bonding was completed 21 days later. Five categories of adhesives were separated. Group A- 3M Trans bond XT (control group), Group B- 3M Trans bond Plus, Group C- Brace Paste (AMERICAN ORTHODONTICS), Group D- Gren Gloo (ORMCO), and Group E- Blue Gloo (ORMCO), along with Clear fill SE primer (Kuraray Noritake Dental Inc, Japan) Universal Etchant, were used to adhere the metal brackets. The brackets were cured with a 3MTM Elipar deep cure-S light-curing device. All samples will be kept in artificial saliva and examined three times using the INSTRON universal testing system to ascertain the SBS: - One week, one day, and one. Descriptive statistics comparing the SBS interval to 24 hours and one week, with a mean and standard deviation that ranges from 6.34 to 9.45 Mpa. The substantial variation in shear bond strength between all of the groups is revealed by one-way ANOVA test groups and within groups. The shear bond strength was highest in Group D, Gren Gloo (ORMCO), and lowest in Group A, 3MTM Trans bond TM XT (control group). Comparing various groups at three distinct time points revealed the confidence interval, which indicated that statistically there was no difference. Among the Five Color changing adhesives, Gren gloo demonstrated average shear bond strength that was significantly higher than other adhesives Blugloo, Trans bond Plus, Brace Paste, and Trans bond XT (Control group) at 24 hrs and one month.

Keywords: Shear bond strength, orthodontic brackets, color-changing adhesive, ARI index.

INTRODUCTION

The adhesion between the orthodontic metal brackets and the enamel surface must be preserved for a fixed orthodontic treatment to succeed. Although bonding failure framesets may not be satisfactory to them, they still greatly increase therapy efficacy and positively impact clinical practice. Often, the wire needs to be cut to make things right, and therapy is much overdue. The use of various adhesives with varying bond strengths and the kinds of orthodontic brackets to which the glue melted can be the subject of this study. Buono core, in 1955 introduced the produced etching technique, where phosphoric acid preparation was used to achieve micro porosities[1]. Newman 1965 introduced the novel concept of bonding orthodontic attachments to tooth surfaces utilizing epoxy adhesive [2]. An experimental study by Zachrison described that a cautiously achieved bonding technique might be on anterior teeth, premolars, and mandibular second molars, while the evidence. At the same time, and would suggest that the first molars be banded[3].To manufacture micro porous surfaces, Buonocore first devised the produced etchings in 1955. The innovative idea of using epoxy adhesive to connect orthodontic attachments to tooth surfaces was first proposed by Newman in 1965. A cautiously executed bonding approach may be used on anterior teeth, premolars, and mandibular second molars, according to an experimental investigation by Zachrison. Additionally, and would recommend that the first molars be banded[4]. Color-changing adhesives are popular and widely used among orthodontists because of the positive traits mentioned. Currently, work is being done to incorporate specific chromatic agents into composite resin glue so that they change color as they cure. They have the advantage of flash removal, which reduces plaque and decalcification buildup and helps patients maintain better dental hygiene. The shear bond strength of composite resin adhesive and either glass ionomer cement or resin-modified hybrid in vitro study has been compared in a study[5]. However, compared to other bonding agents, the benefits of a color-changing adhesive and perception of shear bond strength. The primary finding of the current study is Color color-changing adhesives have strong bond strengths under diverse situations, suggesting that they can be effectively used in orthodontic practice.

MATERIALS AND METHODS

In the current in-vitro study, 150 maxillary first premolars that had recently undergone extraction for orthodontic treatment were gathered, carefully cleaned, and kept at room temperature for two weeks in 0.1 percent (wt/vol) thymol. Premolars were chosen based on the presence of broken teeth, attrited teeth, carious teeth, hypo plastic teeth, cracks on the enamel surface, and gross abnormalities of enamel on the facial and occlusal surfaces,

METHODOLOGY

Extracted maxillary up to the CEJ, which separates the crown surface and is exposed for bonding orthodontic brackets, the first premolar teeth were set with acrylic resin. Before bonding, each tooth was cleaned and polished using a pumice water paste and a rubber cup bur on a slow-speed contra-angle hand piece. The teeth were then rinsed with some water and allowed to air dry.

Brackets
The study used an orthodontic metal upper premolar bracket system with a 0.022 x 0.028 slot (Gemini series, 3M Unitek). The bracket base surface area was found to be 9.61 mm2 as per data provided by the manufacturer (Fig 1)

Light-cure bonding adhesives
The light-cure bonding adhesive used to bond the brackets for the study is as follows (Fig 2):
1. 3M™ Trans bond™ XT (control group)
2. 3M™ Trans bond™ Plus
3. Brace Paste(AMERICAN ORTHODONTICS)

4. Gren Gloo(ORMCO)
5. Blu Gloo(ORMCO)

With long-term marginal sealing, the Clear fill SE primer from Kuraray Noritake Dental Inc. in Japan has stronger and excellent bond strength (Fig 3 a). It has low method sensitivity and, in effect, no post-operative sensitivity. There is no need for a separate acid etching, and the moisture content of the tooth surface requires less monitoring. A 37 percent phosphoric etchant liquid gel known as 3M ESPE Scotch bond Etchant is used to etch enamel and dentin. It has outstanding marginal integrity and high bond strength for highly attractive quality (Fig 3 b).Protective fluoride varnish (Fluor Protector S Ivoclar Vivadent) offers improved defense against teeth erosion and cavities. This cutting-edge varnish technology consistently dissolves fluoride and guarantees immediate fluoride availability. Fluor Protector S provides a compact form of the whole fluoride dose. The varnish's ideal flow and wetting capabilities are caused by its low viscosity(Fig 3 c).

Light cure unit, Stereomicroscope (SEM), and Aluminum-mounting jig
a. 3M ESPE Elipar ™ Deep cure with the intensity of 1,200 mW/cm2.
b. Scanning Electron Microscope (Magnus, Olympus, Japan).
c. Aluminum mounting jig with an Acrylic resin-filled tooth embedded in it. and bond strength test with the In strong machine showing where the de bonding force was applied With two exposures lasting 10 seconds each, 3M ESPE Elipar TM Deep cure with wavelength 430-480 nm and light intensity 1,470 mW/cm2 (-10% /+20%) was used to start the polymerization process (curing time)(Fig 4 a). After the base of the bracket's surface area was de bonded, the properties of the teeth's surfaces were examined using a scanning electron microscope. The base of the bracket slot surface was scanned using a (Magnus, Olympus, Japan) microscope at a magnification of 40, and then progressively examined in detail at a magnification of 100 to find any surface roughness(Fig 4 b).An aluminum-mounting 150mm x 150mm was selected and the tooth was embedded in the jig**.** Mounting a bracket made of aluminum that has the following measurements: A bespoke square block of aluminum measuring 50 mm in length and 30 mm in width was chosen, and a tooth made of acrylic resin fill was inserted into it(Fig c).

Bonding Procedure
Thirty tooth samples of all the Groups were first polished with a super-fine polishing paste (Clean Joy, VOCO), then etched for 30 seconds with 37 percent phosphoric acid, rinsed, and air-dried. At the same time, Clear fill SE Primer

Figure 5 Thirty teeth samples of all the Groups (Group-A 3M Trans Bond-XT, Group – B   3M™ Trans bond™ Plus, Group – C Brace Paste (AMERICAN ORTHODONTICS) Group – D Gren Gloo (ORMCO) and Group – E   Blu Gloo (ORMCO) with color coding stickers on the samples (KurarayNoritake Dental Inc., Japan) was applied in a thin layer to the enamel surface, and then an orthodontic bracket was bonded with Group-A 3M Trans Bond-XT, Group – B 3M™ Trans bond™ Plus, Group–C Brace Paste (AMERICAN ORTHODONTICS)Group – D GrenGloo (ORMCO)and Group – E Blu Gloo (ORMCO)(Fig 5). The surplus flush was eliminated The study used an orthodontic metal upper premolar bracket system with a 0.022 x 0.028 slot (Gemini series, 3M Unitek)., the extra flush adhesive material was removed with a probe before curing, taking care not to compromise the position of the bracket. The adhesive was light-cured for a total of 10 seconds with the Elipar deep cure-S light-curing equipment.

Bond Strength Testing
Following the completion of the bonding operations, the samples were subjected to a shear bond strength test utilizing a universal testing machine (Fig 6). The device consists of two jigs. The stirring component of the machine's cross-load component was where the upper jig was fastened. The stationary component was fastened to the lower jig. The plotter and monitor were connected to the crosshead components. To maintain distance and equal alignment of the labial surface of the tooth and the shear die, the teeth were modified into the jig. A shear knife-edge blade with the same dimension as the bracket imparted the shear force to it at a crosshead speed of the bond strengths were computed in mega pascals, and the shear bond force required to shear the bracket and cause bonding failure was documented in Newtons (MPa). All of the samples underwent the same testing procedure, and the results were

documented. The software Origin 7.1 was used to store the data on a PC (Origin Lab, California, USA). The calculated values were confirmed. In each group of three samples, one sample was chosen whose surface had been treated with 37 percent phosphoric acid. All of the samples were subjected to the test again, and the results were noted and saved. The results attained were noted. The samples were put through a universal testing machine's shear bond strength test at a crosshead speed of 0.5 millimeters per minute. The results were recorded in Newton and converted into the following equation.

Shear bond strength in Mega pascals = De bonding force in Newton's
                                                    Bracket base area (12:6mm2

Adhesive Remnant Index (ARI)
All specimens were inspected after de bonding using a stereomicroscope (Magnum, Olympus, Japan) at 10x magnification to measure the amount of adhesive still present on the tooth surfaces

 The ARI scale has a range of 5 to 1
5 = No composite left over on the enamel surface
 4 = Less than 10% of composite left over the tooth surface
 3 = More than 10% but less than 90% of the composite left over the tooth surface
 2 = More than 90% of the composite left over on the tooth surface
 1 = The entire composite, with an impression of the bracket base left on the tooth surface

STATISTICAL ANALYSIS
The shear bond strength of the five groups is potted as mean and standard deviation. Descriptive statistics, including the mean, standard deviation, and minimum and maximum values, were calculated for each of the tested groups. test for analysis of variance The statistically significant variations in mean Shear bond strength across the five groups were determined using a one-way analysis of variance (ANOVA). Shear bond strength at various intervals between the five groups was examined, and a one-way Friedman test was used to define in which group the statistically significant difference between inter- group multiple comparisons belonged.

STATISTICAL SOFTWARE
Statistical software, Statistical Package for Social Science (SPSS) Version 26.0, was used to analyze the data. Graphs and tables were created using Microsoft Word 2016 and Excel 2016. If a p0.05 percent level of significance and p0.01 was highly significant at a 1 percent level of efficacy, the statistical difference was deemed to be significant.
Graph 1 Comparison of Shear Bond Strength between Different groups at 3 different intervals

RESULTS

Shear Bond Strength
Compared to SBS 24 hours and SBS 1 month, the interval between SBS 1 Week had the greatest P-value in the normality test (Kolmogorov-Smirnova and Shapiro-Wilk): 0.008 (Table 1). When comparing the three intervals of the descriptive statistics of the five groups, Group D GrenGloo (ORMCO) had the greatest descriptive values: the one-month SBS interval had the highest Mean = 7.8940, Standard deviation = 1.06435, a minimum of 6.34 Mpa and a maximum of 9.45 Mpa (Table.2). Shear bond strength comparison between 5 groups at various intervals (Friedman Test) *significance >0.05. At various intervals across the five groups, groups B, D, and E exhibit substantial efficacy of 0.054, 0.006, and 0.008, respectively, which is related to a significant difference in shear bond strength (Table 3). Group D had a significant difference of 0.041, 0.041, and 0.005 between 24 hours and 1 week and 1 week and 1 month, according to an intergroup comparison. Similar to group E, there is a significant difference of 0.001, 0.006, 0.001, and 0.006 for 1 month, 24 hours, and 1 month, 1 week (Table.4). One-way ANOVA was used to compare

groups and within-group differences. The difference between the means of Group D and Group E is statistically significant, as evidenced by the confidence interval for the difference being between 92.221 and 70.203. The differences do not appear to be statistically significant, according to the confidence intervals for the remaining mean groups (Table 5). The confidence range for the ANOVA test comparison between various groups at three separate time points indicated that there was no statistically significant difference (Table 6)(Graph 1).

Adhesive Remnant Index

The ARI scale ranges between 0 and 3, indicating the ARI Score of Group 4 GrenGloo (ORMCO) had less than Twenty five percent ARI of the score of 0 only at 24 h on the tooth than the bracket mesh (Table 7). Because the bond breakdown primarily occurred at the bracket-adhesive interface, the mesh like pattern is visible in the two bracket bases. However, due to the leftover bonding substance, not well defined. There was a noticeable difference between the two groups, showing air bubbles in the residual adhesive on the bracket bases that were bonded and a well-defined resin penetration into the sections of the base bracket in the more substantial occurrence (Figures 7a and 7b).

DISCUSSION

The clinical practice of orthodontics has changed and advanced due to the bonding of braces. To maintain the bond strength, it is necessary to develop the bonding process while reducing time and lowering exposure to volume. They further assert that Grengloo's chemical affinity for metal brackets ensures constant binding strength. Damon 2 brackets (ORMCO) were adhered to using Blugloo and Trans bond XT, two conventional adhesives, to compare their shear bond strengths. They discovered that the bond strengths were far more than those needed to withstand masticatory and orthodontic stresses, and there was no discernible change in the shear bond strength. The findings suggested that employing Blugloo adhesive, which has advantageous color-changing qualities and facilitates adhesive release during bonding [6] did not decrease bond strength. The mean shear bond strength of four adhesives was measured between 16.0 and 22.2 MPa. According to the current investigation, Greengloo has the highest shear bond strength among color-changing adhesives while Trans bond XT has the lowest (control). The Shear bond strength variation between color-changing adhesives was not statistically significant in the present study, however. In the current testing, however, Greengloo's shear bond strength was noticeably higher than any other adhesives'.

According to Bayani et al., the examined groups' shear bond strengths ranged from 14.05 to 31.25 MPa. When light-cured for the 20s, Greengloo adhesive demonstrated the greatest Shear bond strength values, whereas Trans bond Plus adhesive demonstrated the lowest values Trans bond Plus adhesive's ARI scores were much higher than those of the competing glue, and the differences in ARI values were not statistically significant [7]. Shamnur et al. assessed and compared the bond failure rate, bonding time, and time required for the adhesives to change the color of two color-changing bracket bonding adhesives Trans bond Plus. There was no indication that either is clinically effective or efficient. Clinically speaking, the benefit of color-changing bracket bonding adhesives is that they reduce chair side time due to their ability to change colors, which makes it easier to remove flash when bonding brackets [8]. The shear bond strength of a color-changing adhesive and a traditional light-cure glue were contrasted at various de bonding times by Yousse finia et al. Trans bond Plus had the highest mean SBS at 15MPa after one week. In terms of the shear bond at various periods and ARI [9]. Trans bond nd XT tested for one week had the lowest mean SBS of 13.8 MPa, but their graphs and tables were created. According to Scribante et al., in vivo, clinical research should be carried out to confirm the in vitro results. In vitro, bonding studies represent one of the initial stages of materials testing. Studies on color-changing adhesives in vivo are lacking. The study is the first to evaluate the therapeutic efficacy of an experimental resin to a standard one *in vivo* [10]. When Maurya et al. compared the shear bond strengths of glass ionomer (Fuji Ortho), conventional composite resin 3M Trans bond XT, color-changing composite resin 3M Trans bond Plus, and conventional, etch, and 3M Trans bond Plus Self Etch Primer, they discovered that the glass ionomer resin adhesive had the lowest shear bond strength and the light-cure conventional composite resin had the highest. The bonding of Grngloo and Blgloo was equivalent when the shear bond strength of color-changing adhesives was compared to that of the traditional light cure glue [11].

However, Trans bond Plus' bond strength was considerably lower than Light Bond's. The sealant Ortho Solo (ORMCO), which is utilized in Grngloo and Blgloo, may be the reason for their relatively higher bond strengths. Ortho Solo is a universal sealant and bond enhancer that releases fluoride. Ortho Solo, according to its creators, has a bond-enhancing feature that enhances adherence to the tooth at the adhesive interface and lowers bond failure rates. In Ortho Solo, the glass filler serves as a stress and shock absorber, reducing cracks that could cause bond failure [12]. Manufacturers claim that a proprietary chemical used in Grngloo's design boosts traumatic impact resistance by 118%. It is thought that a minimum bond strength of 6 to 8 MPa is needed to support regular orthodontic treatment (Reynolds, 1975) [13]. In our research, the shear bond strength varied significantly. The highest shear bond strength was found in Grengloo, which ranged from 6.34 MPa to 9.45 MPa during 1 month and 24 hours. Bond failure in Grngloo was relatively low compared to other adhesives. Contrary to a related study by Duers et al., 3m Trans boand XT had the highest bond failure rate. For Trans bond PLUS, Blugloo, and Trans bond XT, the average shear bond strength is much greater at 24 hours than at 15 minutes. At 15 minutes compared to 24 hours, Gréngloo's average shear bond strength was more significant. Gréngloo had the highest average shear bond strength after 15 minutes of testing.

At 24 hours, Gréngloo had the weakest average shear bond strength [14]. For usage in clinical orthodontic treatment, the Trans bond Plus, Brace paste, Blugloo, and Gréngloo all showed sufficient shear bond strength. The circumstances in which color changes take place are the main distinctions between the five different adhesives. After exposure to light for the light cure, Trans bond Plus turns translucent from its pink hue. Similar to how Brace paste transforms from a purple color to transparent with exposure to light for light curing, Grengloo and Blugloo transition from green tint and blue tint, respectively, to translucent after an increase in temperature, and their respective color tint returns with a temperature. Bond strengths depend on the technique used, and under different experimental circumstances, the same orthodontic bonding materials can provide varied outcomes .Although clinical research on patients may be of interest to this study, laboratory data cannot be drawn from clinical settings, hence clinical investigations must be conducted to yield meaningful results. Future research should replicate the current study over longer periods and assess the shear bond strength and ARI index 24 hours later. This research was conducted in a lab setting that altered intraoral circumstances. Results in clinical settings may be impacted by elements such as enamel composition, saliva contamination, and differences in assessments between intraoral forces and universal testing machine forces. The dearth of information points to the need for additional clinical investigations on the shear bond strength, the potential for enamel damage, and strategies to reduce the dangers associated with color-changing orthodontic adhesives.

CONCLUSION

Compared to the other adhesives Blugloo, Trans bond Plus, Brace Paste, and Trans bond XT (Control group), Grengloo of the Five Color Changing Adhesives showed an Average Shear Bond Strength that was Significantly Higher. The ARI scores for Greengloo were significantly higher than those for the other adhesives, but they were not significantly different for Blugloo, Base Paste, or Trans bond Plus. The mean Shear bond strength of all the groups remained beyond the safety limit. At three further time intervals of 24 hours, one week, and one month, all the adhesives revealed increased Shear bond strength in comparison to previous orthodontic adhesives.

LIMITATIONS

In comparison to in vivo research, the limitations of this in vitro study's consideration of elements influencing the shear bond strength of the adhesives included saliva, blood, intraoral temperature, occlusal stresses, and others. Therefore, it is advised that research be done to evaluate the shear bond strength of orthodontic bonding adhesives in vivo with all oral variables.

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Table 1: Test for Normality of the P-value Shear bond Strength of different intervals

Test for Normality	P-value
24 hrs shear bond strength	.001
1-week shear bond strength	.008
1-month shear bond strength	.007

Data is non-normally distributed.

Table 2: Descriptive statistics (mean, median, standard deviation, minimum, and maximum value) of the shear bond strength in MPa of study subjects.

Groups	N	Mean	Std. Deviation	Minimum	Maximum
Group A	24 hrs shear bond strength	9	1.5989	1.00711	.18

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	1-week shear bond strength	9	1.2856	.89925	.12
	1-month shear bond strength	9	1.7311	.87479	.56
Group B	24 hrs shear bond strength	10	2.5020	.83708	1.34
	1-week shear bond strength	10	2.1520	.61077	1.23
	1-month shear bond strength	10	2.1680	1.22880	.12
Group C	24 hrs shear bond strength	10	3.4500	1.08338	2.22
	1-week shear bond strength	10	3.4050	1.16299	1.45
	1-month shear bond strength	10	2.5870	.84110	1.23
Group D	24 hrs shear bond strength	10	7.2850	1.47346	4.56
	1-week shear bond strength	10	5.5390	1.90325	2.56
	1-month shear bond strength	10	7.8940	1.06435	6.34
E	24 hrs shear bond strength	10	3.1700	1.49557	1.23
	1-week shear bond strength	10	3.5500	1.14462	1.67
	1-month shear bond strength	10	5.4260	1.00573	3.89

Table 3: Comparison of shear bond strength at different intervals between 5 groups (Friedman Test

Groups	Mean Rank		
Group A	24 hrs shear bond strength	1.89	.895
	1-week shear bond strength	2.00	
	1-month shear bond strength	2.11	
Group B	24 hrs shear bond strength	2.55	.054*
	1-week shear bond strength	1.50	
	1-month shear bond strength	1.95	
Group C	24 hrs shear bond strength	2.30	.273
	1-week shear bond strength	2.10	
	1-month shear bond strength	1.60	
Group D	24 hrs shear bond strength	2.65	.006*
	1-week shear bond strength	1.40	
	1-month shear bond strength	2.55	
Group E	24 hrs shear bond strength	1.60	.008*
	1-week shear bond strength	1.60	
	1-month shear bond strength	2.80	

*significance >0.05
A significant difference in shear bond strength is associated with groups B, D, and E.

Table 4: Intergroup comparison Hoc Tests show that group D 24 hr and 1 week; 1 week and 1 month has a significant difference. Similarly in group E 1 month, 24hrs; 1 month, and 1 week has a significant difference.

Dependent Variable	(I) INTERVALS	(J) INTERVALS	Mean Difference (I-J)	Sig.
A	24 HRS	1 WEEK	.40700	.629
		1 MONTH	.06389	.989
	1 WEEK	24HRS	-.40700	.629
		1 MONTH	-.34311	.730
	1 MONTH	24HRS	-.06389	.989
		1 WEEK	.34311	.730
B	24HRS	1 WEEK	.35000	.680

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		1 MONTH	.33400	.703
	1 WEEK	24HRS	-.35000	.680
		1 MONTH	-.01600	.999
	1 MONTH	24HRS	-.33400	.703
		1 WEEK	.01600	.999
C	24HRS	1 WEEK	.04500	.995
		1 MONTH	.86300	.170
	1 WEEK	24HRS	-.04500	.995
		1 MONTH	.81800	.201
	1 MONTH	24HRS	-.86300	.170
		1 WEEK	-.81800	.201
D	24HRS	1 WEEK	1.74600*	.041*
		1 MONTH	-.60900	.647
	1 WEEK	24HRS	-1.74600*	.041*
		1 MONTH	-2.35500*	.005*
	1 MONTH	24HRS	.60900	.647
		1 WEEK	2.35500*	.005*
E	24HRS	1 WEEK	-.38000	.772
		1 MONTH	-2.25600*	.001*
	1 WEEK	24HRS	.38000	.772
		1 MONTH	-1.87600*	.006*
	1 MONTH	24HRS	2.25600*	.001*
		1 WEEK	1.87600*	.006*

Table 5: ANOVA comparison of SBS between groups and within groups

		Sum of Squares	Difference	Mean Square	F	Sig.
A	Between Groups	.949	2	.475	.491	.617
	Within Groups	25.111	26	.966		
	Total	26.061	28			
B	Between Groups	.781	2	.391	.453	.640
	Within Groups	23.253	27	.861		
	Total	24.034	29			
C	Between Groups	4.720	2	2.360	2.189	.131
	Within Groups	29.103	27	1.078		
	Total	33.823	29			
D	Between Groups	29.885	2	14.942	6.472	.005
	Within Groups	62.337	27	2.309		
	Total	92.221	29			
E	Between Groups	29.178	2	14.589	9.601	.001
	Within Groups	41.025	27	1.519		
	Total	70.203	29			

Table 6: ANOVA comparison between different groups at 3 different intervals.

		Mean Square	F	Sig.
24 hrs shear bond strength	Between Groups	45.605	30.129	.000

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	Within Groups	1.514		
	Total			
1-week shear bond strength	Between Groups	25.042	16.735	.000
	Within Groups	1.496		
	Total			
1-month shear bond strength	Between Groups	67.956	65.893	.000
	Within Groups	1.031		
	Total			

Table. 7: ARI Score Different groups with the three intervals

Intervals	color-changing adhesives	ARI Score			
		Score 0	Score 1	Score 2	Score 3
24 Hours	3M™ Transbond™ XT	1	2	3	2
	3M™ Transbond™ Plus	1	2	2	2
	Brace Paste	1	2	1	4
	GrenGloo	3	1	1	0
	BluGloo	2	2	2	1
1 Week	3M™ Transbond™ XT	0	1	2	3
	3M™ Transbond™ Plus	1	2	2	2
	Brace Paste	0	2	2	2
	GrenGloo	3	1	1	0
	BluGloo	2	1	1	1
24 Month	3M™ Transbond™ XT	1	1	0	3
	3M™ Transbond™ Plus	1	2	1	2
	Brace Paste	1	1	2	2
	GrenGloo	3	1	0	0
	BluGloo	2	2	1	1

ARI=Adhesive remnant index[*]
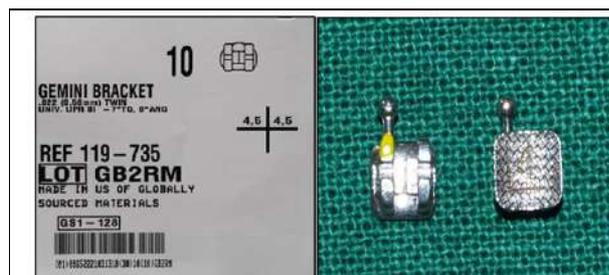
Figure 1: 3M™Unitek Gemini series upper premolar metal brackets	**Figure 2: The light cure bonding adhesive used to bond the brackets for the study; 3M™ Transbond™ XT (control group), 3M™ Transbond™ Plus, Brace Paste(AMERICAN ORTHODONTICS), GrenGloo(ORMCO), and BluGloo(ORMCO and Clearfill SE primer (Kuraray Noritake Dental Inc, Japan).**

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Figure 3: The light cure bonding primer and etchant used to bond the brackets are Clearfill SE primer (Kuraray Noritake Dental Inc, Japan),3M ESPE Scotchbond™multipurpose universal etchant, and Fluoride Varnish (Fluor Protector S)
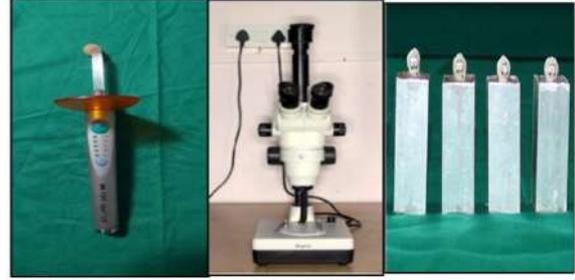
Figure 4: a.3M ESPE Elipar™Deepcure with the intensity of 1,200 mW/cm2. b. Scanning Electron Microscope (Magnus, Olympus, Japan). c. Aluminum mounting jig with an Acrylic resin-filled tooth embedded in it. and bond strength test with the Instron machine showing where the debonding force was applied

Figure 5: Thirty teeth samples of all the Groups (Group-A 3M TransBond-XT, Group – B   3M™ Transbond™ Plus, Group – C   Brace Paste (AMERICAN ORTHODONTICS) Group – D GrenGloo (ORMCO) and Group – E   BluGloo (ORMCO) with color coding stickers on the samples

Figure 6: Universal Testing Machine

Figure 7 Scanning electron micrographs of the bracket base after debonding
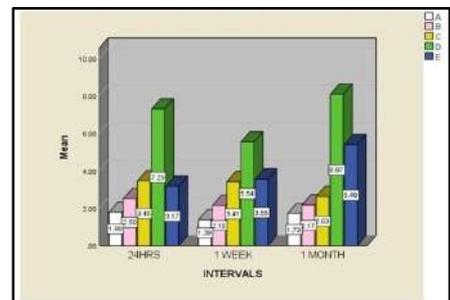
Graph 1: Comparison of Shear Bond Strength between Different groups at 3 different intervals

RESEARCH ARTICLE

A Study on Predictors of Emotional Labour Management in Customer Facing Apparel Store Employees

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ABSTRACT

Emotional labour the word sinc e 1983 generally encompass, work that goes unpaid and unrecognized. After entering into the world of "employees   emotion" the word emotional labour adding more meaning to the customer facing employees emotion. Even the limited research in this emotional labour field, it is very new to Indian context so The present study aims to examines how some characteristics and some strategies like employee attitude towards Store, job benefits, organization a support, store image, emotional intelligence, personal values and gender effects in a employees emotional labour Management. In addition, the study investigates the role of above mentioned strategies act as a predictors of employees emotional labour Management. To find out the structured data, self-designed questions were coined, especially for customer facing employees in apparel stores which are in chennai. Totally 213 valid responses were obtained to predict the Employees Emotional Labour. Managing emotions is not a easy task. Employees need to get trained to express their expected emotion, so the study also examined how the employee genuinely cared for their organisation by the help of emotional labour. This study results offered crucial theoretical and managerial implications which serves as a value addition to the prevailing Emotional Labour research.

Keywords: Emotional labour, job benefits, organisational support, store image, emotional intelligence, personal values.

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INTRODUCTION

Directing our Emotion is an art. People are managing their emotions by practicing mindfulness, yoga, meditation etc. Numerous people of the total population living in this world will be as workers. It is more important to pay attention to our emotions where we are as a worker than it is to look at our emotions as an individual. Hoch child(1983 the managed Heart,) explained that regulating and directing the emotional Appearance of the Emotions with the persons who are facing for to meet the organizational expectations in their professional work role. In many places the phrase "our service with a smile". 'Is this possible in the sense of "labor" emanating from the human brain, which is a pile of different emotions?' The question naturally arises for all of us. It is imperative to express the same feelings to all the clients they meet while being a worker. For that, companies also need to balance the mindset of workers. Various external factors and self-factors of the worker affect all workers to express the same feelings especially positive emotions to fulfill the purpose of the company. In this research article we will look at the various hitherto undefined factors involved in managing Emotional Labor Management in that category. As like words of Arlie Russell Hoch child this paper is going to explore the new dimensions of managed hearts. Service industry accounts for above 60% of global GDP and the economy (the sector fact book, 2017), growing research has targeted on frontline service personnel' behaviors, attitudes, and emotions (grandey,2008;mayer et al., 2009; dong et al., 2015). All through carrier delivery, but, employees ought to agree to organizational expectancies and dreams to suppress negative feelings and Display good feelings, which is characterized as emotional exertions (ash forth and humphrey,1993; brother ridge and grandey,2002).Emotions exertions contains different displaying guidelines: Surface acting and deep Acting. Surface acting emphasizes converting outward emotional show as opposed to altering the internal genuine emotions (Abraham, 1998; grandey, 2000),while deep acting highlights regulating the internal emotions to satisfy necessities of the paintings grandey, 2000;hülsheger and schewe,2011)

Objective of the Study
This Exploration aims to identify the various predictors and their effect on emotional labour management among apparel store employees in Chennai.

REVIEW OF LITERATURE

The increase in Service providing enterprise the importance of personnel' emotional exertions has triggered, and it has acquired accelerated interest from various fields which includes organizational conduct and organizational psychology (Grandey and Gabriel,2015). Grandey (2000) stated that emotional labor can negatively affect employees' task pleasure, and the task satisfaction has robust implications for attendance, turnover, sabotage, job overall performance, and the mental and bodily health of personnel (Miao et al., 2017).A variety of research have found that emotional Labour work required by using organizational norms can negatively have an effect on character well-being (Hülsheger and Schewe,2011).The end result of another study affords the assist for moderating effect of emotional intelligence on how employees' Deep Acting and Surface Acting apprehend clients' reactions that might have an effect on employees' Emotional Exhaustion and Job Satisfaction, and consequently, Turnover Intention (Young Hee Lee1, Suk Hyung Bryan Lee and Jong Yong Chung 2019).Since 1980s, the presence and manifestation of emotions in work life and the role of emotions in corporate success has been discussed increasingly (Secer,2005). The concept of emotional labor, which arose accordingly, was mentioned for the first time in 1983 inside 'The Managed Hearth' of Hoch child and was defined as the management of emotions that are expressed through face or body in return for a p rice, for anybody to be able to observe (Wharton, 2009).

Thereby, making sure that a certain emotional signal would be delivered to the other party through manners during the work was now considered to be among the necessities of many jobs, as a feature of the job role that is undertaken (Secer,2005). Especially in the service sector, or in health and education professions which necessitate human relations, as emotional capabilities gained importance (Savas,2012;Kaya & Tekin,2013), the concept of emotional

labor was defined to be a second duty that should be exercised along with basic tasks (Ozkan,2013), or the nameless duty that the workers should be performing while doing their work.

Emotional Labour Management

To Analyses the Dependent variable (ELM) this study refers to the degree of ease with which an employee manages emotional labour at workplace. In the Questionnaire scale 4 items adopted from Adelman (1995). Focal factor whether or no longer or now not emotional Labour work is a possibility of job stress evolved a measure of emotional labour work in a sample of employees employed in an career requiring a immoderate degree of emotional labor and explored how the kind of and amount of emotional labor are associated with employee reactions in their job. so this study adopted following aspects to measure ELM. First predominant influencing value is "Induce feelings" . It will produce an emotional state in employee; that leads to make the customers to feel the importance of the product in their life. And to make the customer to like and trust the brand. Because trust is playing a important role in buying. Then they'll unfold the word quickly to friends, thru social media, and on overview sites (Jenn Goddu 2021). This will actually fits in the view of employee also. The term "expressive behavior" refers to ease elements of conduct which seem motivational states. "expressive behavior" is used proper right here to cover emotional attitudes and moods, cognitive attitudes (interest, attention), activation states (arousal, fatigue), and extra-or-much less eternal attitudes which can be character attributes.(Bain 1859; Lipps 1905; Scheler 1913). In the way the term "worker expressive behavior" is refers to smile and behave in a friendly manner towards the customer. Customers have sure expectancies that ought to be met while buying a product. Expectancies are private visions of the outcome of an experience and can be positive or terrible. Those expectancies are based on a purchaser's perceptions. It is critical for agencies to comprehend that customers have different degrees of expectations. There are two simple degrees: number one expectancies, which might be a client's maximum simple requirements for an interplay, and secondary expectancies, which might be based totally on previous studies that function improvements to number one expectancies (Helen Jeske; Edith Chimusoro ;Anis Mahomed Karodia 2015). Based on this mentioned study "to conceal any negative feelings about the customer" is a vital task in emotional management. Precise customer service looks as if common experience for all employees.The average of these 4 item ratings is taken and The average values above or equal 2.5 is considered as ease in management of emotional labour and coded as '1'.The average values below 2.5 is considered as difficulty in management of emotional labour and coded as '0'. This study aims to check the factors which affect the employees' management of emotional labour.

Employee Attitude towards the Store

To Identify the emotional Labour of people working in mall, Employee attitude plays a vital role. Consistent with the perceived nature of the employment Relationship, Employee- organisation relationship (EOR) idea demonstrates that the connection among the agency and personnel involves a chain of perceived interactions that generate duties to reciprocate (Cropanzano and Mitchell, 2005).Some researches presents proof of the connection among perceived store image and selection making, even though the varieties of choice range significantly (fair cloth, et al., 2001; jin & kim,2003; osman,1993;ward,bitner & barnes,1992). Robust guide was discovered for the connection between shop image belief and both patronage preference (amirani & gates,1993;paulins & geistfeld,2003;thang & tan, 2003) and approach/avoidance behaviour. However, research indicated that in a few instances the relationship between keep picture perception and technique/avoidance behaviour became mediated by way of emotional Labour (Donovan &rossiter,1982; moye&giddings,2002; ward et al., 1992). Hence Hypothesis is framed as Follows

Employee Attitude towards the Store Positively Influence Emotional Labour Management

Employee Attitude towards the Store is refers to the set of emotions, beliefs, and behaviors that an employee has believes toward the store. To analyze Employee Attitude towards the Store scale adopted from Cook and Wall (1980).

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Job Benefits
In today's hiring field, Employees expect bundle of benefits. And also it is important for attracting and preserving top talent. Employment self assurance survey was conducted in Reviewing Platform called glassdoor (2015), about 60% of Employees report that remuneration and perks are a prime thing in thinking about whether to just accept a task offer. The survey additionally determined that 80% of personnel could pick extra Benifit over a pay increase. Google is famous for its over-the-top perks, which consist of lunches made by using a professional chef, biweekly chair massages, yoga training, and haircuts. (Kerry Jones , 2017)Without tremendous skills, no business method will be victorious. Without dedicated talent, no enterprise strategy will closing. Long past are the times even as a immense salary and more than one weeks of paid time without work were sufficient to draw and keep skills. Rising from the pandemic, personnel need more meaningful and greater holistic benefits (Rachel Ranosa 2021) Worker benefits are rewards that the organisation gives to personnel best for the truth that they are its employees. Normally, they may be not tied to employee overall performance. Sometimes but, they depend on repute of worker inside the organization, his merits and the time he has labored in the corporation. Worker blessings may be segmented into 3 simple groups (strenitzerová,2015.) advantages of a social nature (corporate pensions, existence insurance, enterprise loans and guarantees for loans, child care employees (nurseries and kindergartens), and many others..), blessings of work nature (meals, discount for company products to personnel, language tutor ,and many others..)They refer to the employees' perception of the monetary as well as non-monetary remuneration, gains and rewards they receive in their job. Hence Hypothesis is framed as Follows

Job Benefits has a significant positive role in Emotional Labour Management
Organizational Support
Perceived organizational support is a belief of an employee that the organisation values their contributions and cares about their well-being (eisenberger et al., 1986).After eisenbergeretal. Proposed the idea of perceived organizational support, after that scholars mainly focused on the development of size scale, the factors affecting perceived organizational aid, and the fine impact of perceived organizational aid on employees and corporations via empirical studies. The antecedent variables that affect perceived organizational guide can be summarized as three classes, such as organizational elements, person elements, courting among organisation or organizational dealers and personnel. Among them, the organizational factors encompass organizational fairness, working situations, organizational political behavior, organizational size, organizational cultures. Individual factors consist of values, nice or bad emotions, pre-hiring experience, paintings reputation and other variables." dating between employer or organizational marketers and employees include mental settlement, worker-company healthy, chief-member trade, control communication, leadership style and other variables. (Hochwarter,2003;Eisenberge & Stingl hamber,2016),It refers to an employee's perception that the organization values his or her work contributions and cares about the employee's well-being. Hence Hypothesis is framed as Follows

Organizational Support has a significant positive effect on Emotional Labour Management
Store Image
In summary, behavioral definition of shop loyalty is an inclination of clients to buy repetitively in a time frame and it can be operationally described and measured as purchase ratio as repetitive buy behavior (raj 1982), purchase frequency. By the usage of these definitions, it can be objectively measured and has a bonus of distinguishing shop loyalty for numerous shops. But it has limitations that researchers can effortlessly use subjective decisions and that it's miles tough to explain how the shop loyalty is formed and why it modifications. Store Image is Defined as, The concept of store image become used by means of Martineau (1958) for the primary time. He defined it as "a store described in customers' thoughts partially primarily based on practical attributes and partially based totally on mental attributes." he claimed that keep image consists of its characteristic attributes and it makes customers sense the store extraordinary from others. Useful attributes are assortment of commodities, layout, region, price value relation, and provider that purchasers can objectively examine with different shops. Mental attributes are elegance and luxuriousness that constitute special attributes of that keep It is the sum of impressions of the store in the minds of customers. Hence Hypothesis is Framed as Follows

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Store Image has a significant positive role on Emotional Labour Management
Emotional Intelligence
There are elements that resonate with management style, overall performance and behaviour, namely emotional intelligence (EI) or emotional quotient (EQ). The term emotional intelligence (EI) changed into first coined by means of mayer and salovey (1990) wherein they advised that ei changed into a intellectual technique in which formerly independent variables such as questioning and feeling paintings in partnership. George (2000) asserts that EI is the diploma wherein emotions are cognitively managed. Stein (2009) on the other hand defines EI because the ability to "tune in to the sector, study conditions and to connect to others while taking fee of your very own existence". Salovey and mayer (1990) at first defined emotional intelligence as social intelligence. This resonates with the capacity to analyse the emotions and feelings of one's self and of others and to utilise the knowledge to form individual's thinking and movements consequently. Income managers will often recruit income people structured upon a mess of different standards together with individual, personality, skills and intelligence (IQ). Those elements are frequently considered to be key characteristics in terms of supporting the recruitment choice of a sales character. According to cherniss (2000) IQ alone isn't always a superb predictor of job performance and this statement was in addition reinforced via hunter and hunter (1984) who contend that iq will handiest account for twenty-five percent of the variance in terms of a person's performance. It refers to the ability of an individual to perceive, control, and evaluate emotions. Consistent with cherniss (2000) the pace of change maintains to increase through the world of paintings wherein there are more expectations and needs positioned upon someone's cognitive, emotional resources and therefore those set of equipment turns into extra pertinent in these days dynamic operating surroundings. The Scale of Wong and Law's (2002) EI scale – specifically Self-emotion appraisal (SEA) and Others' emotion appraisal (OEA) items were adopted. Hence Hypothesis is framed as Follows

Emotional Intelligence Support is completely produce favour effect on Emotional Labour Management
Personal Values
A noted study by morgeson and Humphrey (2006), autonomy has a significant place in motivational work tactics. Further to being the most broadly studied activity characteristic, it's also the maximum influential (humphrey and morgeson,2008). Moreover, activity autonomy is the activity characteristic associated with innovative behavior ((Liu Et Al 2011 De Spiegelaere Et Al., 2014; Orth And Volmer, 2017), and it also appears to be related to Personal values. Thus, we concentrate on process autonomy in our take a look at.

We anticipate that an person can attempt to have extra independence at their job whilst it is congruent together with his/her Personal values. As Personal values have been verified to develop in the early levels of lifestyles after which be highly strong across time (vecchione et al.,2015, 2016;cieciuch et al., 2016), and as job autonomy is more likely to exchange in terms of the organizational context, the job itself, and the connection among the supervisor and the subordinate (hackman and oldham,1976, 1980), we deal with values as predictors of process Individually. Primarily based on schwartz's (1992) principle, we assume that employees may be extra or much less disposed toward seeking Individuality of their job based on the fundamental personal values they decide on. Someone can be tremendously inspired to have an opportunity to make choices and experience independent at work because it's miles of critical importance to him/her, at the same time as some other character may awareness on different attributes of the task and no longer strive for Individual due to the fact does not don't forget it to be vital for job. As referred to by means of sagiv and roccas (2017) The idea of basic Personal Values proposed by way of Schwartz,(1992) is presently considered to be the most complete and empirically grounded technique to human values (sagiv et al., 2011a; cieciuch,2013). Schwartz argued that values are "suited trans situational dreams, various in importance, that function guiding ideas within the existence of someone or different social entity" (schwartz,1994, p. 21). Values have motivational power by presenting route and emotional depth to movement and by using being received thru socialization, in the context of dominant organization values, as well as thru character studying (schwartz, 1994). The central assumption of the theory is that primary values shape a popular, round continuum and are organized in accordance with the inducement that they explicit. Relationships among motivations can be like minded, conflictual or inappropriate to one another (schwartz,1992). Due to its structure, the price continuum can be partitioned in

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distinctive manners (sagiv and roccas,2017). They refer to broad desirable goals that motivate people's actions and serve as guiding principles in their lives. So indigenously self created scaled used to prove the following hypotheses**.**

Personal Values influence in a positive way on Emotional Labour Management

RESEARCH METHODOLOGY

The Dependent Variable of the study is Emotional Labour Management (Binary variable). The study aimed to prove the relationship between Emotional Labour Management and Employee attitude towards store, Job Benefits, Organizational Support, Store Image, Emotional Intelligence, Personal Values, and Gender. In the survey Independent Variables and All metric variables measured on a 5-point Likert scale except gender. This study aimed to look out apparel stores in Chennai, one of the top metropolitan cities in India. The sample consisted of personnel operating in 3 retail formats. That means Small-scale apparel stores, electronics and domestic home equipment stores and cell phone shops. A total of 24 retail shops were selected based totally on their proprietor/supervisor's consent and criterion that the store assistants/employees at once interacted with clients to promote their merchandise. The sample comprised fifty seven percentage male and forty three percentage female employees between 24 to fifty eight years of age and their month-to-month earnings starting from rs. 4,000 to rs. 20,000. The self-document questionnaire changed into administered to all the front-line employees inside the decided on shops. Typical, 238 valid responses had been received which have been used for similarly analysis. The conceptual framework encapsulating the predictors of emotional labour management of consumer-facing employees is presented in Figure 1.

Analysis and Interpretation
Stage 1: Exploratory Factor Analysis
Objective - To test the grouping of the items into seven constructs hypothesized in the conceptual framework

Stage 2: Logistic Regression
Objective – To identify the significant predictors and its impact on emotional labour management of apparel store employees. In other words, logistic regression was performed to ascertain the effects of hypothesized variables on the likelihood that the employees find it easy to manage emotional labour.

The logistic regression results are presented below:
Estimation terminated at iteration number 6 because parameter estimates changed by less than .001.
The explained variation in the dependent variable i.e. emotional labour management is indicated by Cox & Snell R Square and Nagel kerke R Square values which are also referred as pseudo R^2 values. Note that these values can be interpreted in the same manner as R^2 values in multiple regressions, but with more caution. As presented in Table 3, we can conclude that 42.2 to 56.5 percent of variation in the dependent variable is explained by the predictor variables in the model. Table 4 presents the Hosmer and Leme show Test which is used to evaluate the model goodness-of-fit. The output returns a chi-square value and p-value where a significant p-value indicates poor model fit. Here, the p-value is 0.057 which is insignificant (>0.05) implying that the logistic model is a fairly good fit for the data. Logistic regression estimates the probability of an event occurring which in this case is the ease in managing emotional labour by the employees. The classification table above presents the classification accuracy of the model which is found to be 79.2 percent. In other words, the model is able to predict 79.2 percent of the cases correctly which is a fairly acceptable predictive power for a logistic model. The logistic regression output in Table 6 shows that six out of seven input variables emerged as significant predictors of emotional labour management of the employees since their p-values (Sig.) were below 0.05. Except personal values variable, the other measurement variables in the model i.e. employee attitude towards store, job benefits, organizational support, store image and emotional intelligence had a positive impact on emotional labour management, since the adjusted odds ratio i.e. Exp(B) for all variables were above 1.0. Hence, their confidence intervals are entirely above 1.0 which implies that an increase in these predictor variables increases the odds of the outcome i.e. improves the employees' ease of emotional labour

management at their job. Job benefits perceived by the employee was found to be most important predictor with the highest adjusted odds ratio of 6.734. This signifies that for every unit increase in perceived job benefits of the employees, there is 6.734 times higher odds of them able to easily manage emotional labour at their job. Employees' attitude towards the store was found to be the second impactful predictor with an odds ratio of 2.773 which denotes that for every unit increase in employees' attitude towards the store, there is 2.773 times more likelihood of them managing emotional labour with ease. Emotional intelligence of the employees was identified as the third significant predictor of emotional labour management with an odds ratio of 2.733. This implies that every unit increase in emotional intelligence of the employees translates to 2.733 times higher odds of them experiencing ease in managing emotional labour at their job. Gender was found to be the next important predictor of emotional labour management with an odds ratio of 2.543. This indicates that compared to male employees, female employees were 2.543 times more likely to easily managing emotional labour at their workplace. Organizational support and store image were the other variables with comparatively lower predictive effect indicated by odds ratio of 2.197 and 1.739 respectively. Thus, employees who have better organizational support and perceive superior store image are more likely to easily managing emotional labour at their job.

CONCLUSION AND RESEARCH IMPLICATIONS

This study explored the emotional labour management among customer-facing employees working in small retail stores in Chennai. While past research has primarily analysed emotional labour (EL) in terms of the degree of emotional work experienced and type of strategy used (surface acting and deep acting), this study is a one-of-its-kind to evaluate EL in terms of ease of its management. The study proposed and validated a new conceptual framework incorporating the various determinants of employees' ease of emotional labour management. The logistic regression analysis revealed that employees' perception of their job benefits, their positive attitude towards the store and emotional intelligence are the most important factors determining the ease of emotional labour management. Gender also played a significant role where female employees found it easier to manage emotional labour. Besides, organizational support and store image were also significant predictors of ELM. The study findings offer crucial research and managerial implications for various stakeholders such as academicians, retailers and human resource managers.

From the research/academic perspective, the study findings offer numerous theoretical implications. Job benefits was found to be the most significant predictor suggesting that monetary and non-monetary benefits perceived by employees not just affects their job satisfaction (validating Equity theory), but also improves their psychological motivation to manage emotional labour effectively. Employees' positive attitude towards the store found to be the second most significant predictor of emotional labour management validates the Herzberg's Two-Factor theory of Motivation. The validation of emotional intelligence–emotional labour management relationship corroborated Grandey's (2000) emotional regulation model and Job Demand-Resources theory. The finding that female employees in customer-facing roles more effectively manage emotional labour corroborate the theory that women excel at handling interpersonal aspects of emotional labour since they possess better empathetic accuracy than men (Vial & Cow gill, 2022). Organizational support emerging as a significant predictor of emotional labour management substantiated the Grandy's model and reciprocity principle based on Social Exchange theory. Thus, this study was able to validate some of existing theories and relationships in organizational behaviour as well as offer some new findings and insights as a value addition to the existing EL literature. In small-scale retailers, the employees who directly interact with customers to make sales have an emotionally laborious job which plays a crucial role in retailer's success. These employees directly responsible for sales require higher ELM (Justus & Ramesh,2009). Since employees' perception of job benefits, attitude towards store, organizational support and store image are the important predictors, the store officials must care for and invest appropriately in their human assets by providing training, incentives, encouragement and recognition for their hard work. Its only when the employees feel that they are genuinely cared for by their organization, they are emotionally involved and can effectively handle an emotionally laborious job. A worker has an obligation to express positive feelings towards the employer during the

work period. It is very important to make employees to understand the need to manage their emotions. The findings reiterate the importance of training effective emotion al labour management to employees. It is essential to recruit the right people for this job who are emotionally intelligent with good emotion regulation and social networking skills. The retail managers can employ EI tests during recruitment of new employees and training of existing employees to improve their EI. In addition, the employees should be offered optimal job benefits based on their role and performance since they have a huge impact on their emotional labour management and turnover intentions. In addition, the supervisor/owner should support their employees by providing necessary resources, help, motivation and recognition besides showing care and concern for their well-being. Employees function on the principle of reciprocity insinuating that only a healthy two-way employee-employer relationship with mutual understanding and benefits can thrive and sustain. The key to retailer success is to employ emotionally intelligent frontline employees and provide the right mix of resources, job benefits and supervisor support to help them manage EL effectively which in turn will improve their performance and longevity in the organization.

Limitations and Future Research Directions

This study performed the use of a small sample of employees operating in 24 small-scale retail shops in Chennai and the retailers were selected using convenient sampling technique. Hence, essential warning needs to be taken earlier than generalizing the results.   Only few variables were considered to prove the relationship between Emotional Labour Management .In fact, there can be numerous other factors influencing the ELM which can be used in other type of retail store employees. Future studies can focus on validating the conceptual framework using a bigger, numerous pattern. Researchers can also examine the emotional labour management of personnel running in other type of retail formats and inspect the differences. In addition, extra constructs inclusive of customer orientation, coping skills, coaching , mentoring, and Employee welfare can be integrated within the conceptual framework and examined. The employees' control of emotional labour can be verified with supervisor comments and sales facts from outlets.

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Table 1: KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.88
Bartlett's Test of Sphericity	Approx. Chi-Square	5219.37
	Df	820
	Sig.	0.00

Table 2: Exploratory Factor Analysis Results

Items	Mean	Standard Deviation	Factor Loadings	Cronbach's Alpha Reliability Coefficient
EL1	2.69	1.21	0.790	0.854
EL2	2.65	1.17	0.713	
EL3	2.48	1.18	0.730	
EL4	2.40	1.22	0.743	
EA1	2.80	1.05	0.836	0.900
EA2	2.86	1.15	0.607	
EA3	2.85	1.07	0.680	
EA4	2.87	1.13	0.632	
EA5	2.90	1.10	0.616	
EA6	2.88	1.14	0.640	
JB1	2.92	0.77	0.857	0.827
JB2	2.88	0.75	0.680	
JB3	2.90	0.76	0.723	
JB4	2.89	0.79	0.614	
JB5	2.86	0.77	0.685	
JB6	2.92	0.81	0.708	
OS1	2.63	0.81	0.656	0.765

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OS2	2.62	0.79	0.871	
OS3	2.51	0.82	0.672	
OS4	2.53	0.82	0.677	
OS5	2.61	0.81	0.669	
SI1	2.91	0.95	0.888	
SI2	2.81	0.99	0.684	
SI3	2.87	0.96	0.583	
SI4	2.77	0.95	0.609	0.821
SI5	2.94	0.92	0.671	
SI6	2.74	1.00	0.636	
SI7	2.94	0.92	0.656	
EI1	2.96	0.97	0.769	
EI2	2.98	0.98	0.663	
EI3	2.95	0.97	0.760	
EI4	2.94	0.90	0.715	0.891
EI5	3.00	0.95	0.707	
EI6	2.95	0.97	0.720	
EI7	2.93	0.92	0.717	
PV1	2.85	0.99	0.874	
PV2	2.83	0.98	0.656	
PV3	2.82	0.97	0.679	
PV4	2.89	0.94	0.738	0.819
PV5	2.83	0.99	0.616	
PV6	2.85	1.00	0.605	

Factors	Sums of Squared Loadings	% of Variance	Cumulative %
EL	9.354	22.816	22.816
EA	4.157	10.138	32.954
JB	2.975	7.256	40.210
OS	2.648	6.459	46.668
SI	2.391	5.832	52.501
EI	1.462	3.566	56.066
PV	1.058	2.580	58.646

Note: EL – Emotional Labour, EA – Employee attitude towards store, JB – Job benefits,
OS – Organizational support, SI – Store image, EI – Emotional intelligence, PV – Personal values

Table 3: Logistic Regression – Variance Explained

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	227.078[a]	0.422	0.565

Table 4: Hosmer and Lemeshow Test

Step	Chi-square	df	Sig.
1	15.13	8	0.057

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Table 5: Logistic Regression - Classification Table

Observed		Predicted		Percentage Correct
		Emotional Labour Management		
		Difficult	Easy	
Emotional Labour Management	Difficult	128	22	85.3
	Easy	35	89	71.8
Overall Percentage				79.2

a.   The cut value is .500

Table 6: Logistic Regression – Effect and Significance of Independent Variables

Variables	B	S.E.	Wald	Sig.	Exp(B)
Attitude towards store	1.020	0.298	11.736	0.001**	2.773
Job benefits	1.907	0.381	25.065	0.000**	6.734
Organizational support	0.787	0.314	6.288	0.012*	2.197
Store image	0.553	0.281	3.878	0.049*	1.739
Emotional intelligence	1.005	0.357	7.932	0.005**	2.733
Gender	0.933	0.337	7.678	0.006**	2.543
Constant	-15.764	2.120	55.295	0.000**	0.000

Dependent variable: Emotional labour management (0-difficult, 1-easy)
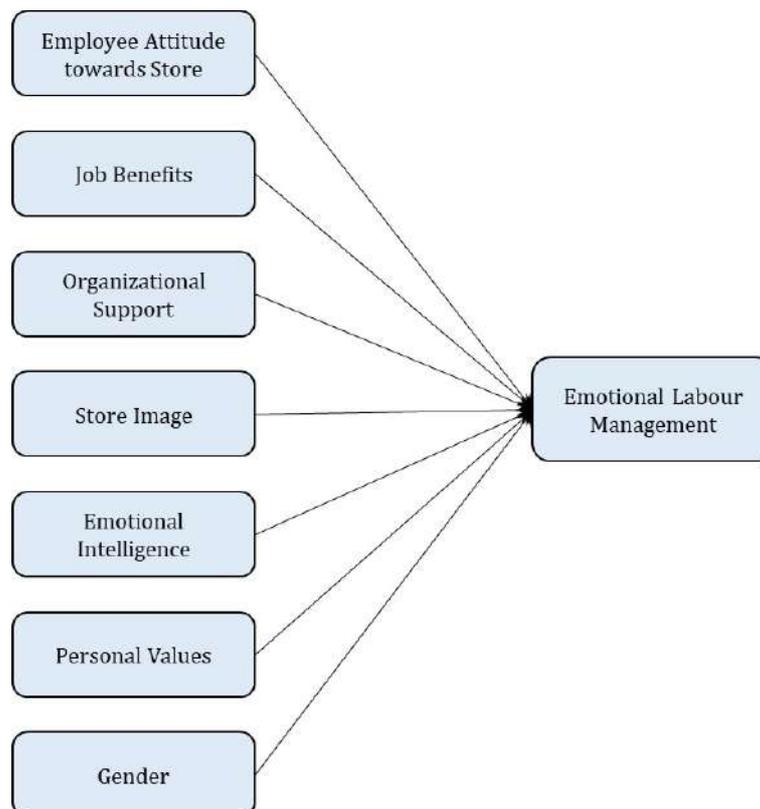
Figure 1: Proposed Conceptual Framework

RESEARCH ARTICLE

Selection of Multiple Deferred Sampling (0,2) Plan with Zero – Inflated Poisson Distribution

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ABSTRACT

The multiple deferred state sampling MDS (0,2) plan generation and selection using the zero-inflated Poisson model is presented as a new method in this research. Models are created at the risk of both the producer and the consumer for a predetermined acceptable and limited quality level. This provides a mechanism for choosing the ZIP multiple deferred state sampling MDS (0,2) based on various entry parameter combinations. Tables for figuring out the corresponding AQL and AOQL are also provided.

Keywords: Average Outgoing Quality Level (AOQL), Acceptable Quality Level (AQL). Zero-inflated Poisson distribution with Multiple Deferred State Sampling MDS (0,2) Plan.

INTRODUCTION

An essential tool for statistical quality control is acceptance sampling. Through inspection from the raw stage to the final stage, this tool is utilized to improve the product's quality. If the product is not properly inspected or tested, it could harm the brand's reputation on the international market. The demand for quality items will rise, which will also raise the company's profits when they are released onto the market following examination. As a result, industrial engineers are paying attention to sampling plans. The main goal of sampling inspection is to lower inspection costs while ensuring that the customer will be satisfied with a sufficient degree of quality on the products being inspected. Quality assurance includes the inspection of raw materials, semi-finished goods, and finished

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goods. Acceptance sampling is the common name for the process used when inspection is done with the intention of accepting or rejecting a product and is based on adherence to a standard. Sampling is frequently used in both government and business to regulate the quality of the transportation of raw materials, supplies, and finished goods. Worth am and Baker established the idea of the Multiple Dependent (or delayed) State (MDS) sampling plan (1976). The MDS sampling plan is a member of the class of conditional sampling techniques. In these producers, a lot's acceptance or rejection is based not only on the sample from that lot but also on the sample results from prior lots or from future lots, as well as the sample from that lot (in the case of deferred state sampling). The operational technique and characteristics of the attributes MDS sampling plan may be found in Worth am and Baker (1976) and this plan was researched further by Vaerst (1982).Tables for the selection of the multiple deferred state MDS-1 sampling plan using the Poisson distribution have been provided by Subramani and Govindaraju in 1990 for the stated acceptable and limiting quality levels. Suresh (1993) suggested methods for choosing a Multiple Deferred State Sampling plan of type MDS and MDS- 1 index while taking filter and incentive effects into account.

When dealing with data made up of numerous over-dispersed zeros, the Zero-Inflated Poisson (ZIP) distribution is the best choice. Several academic fields, including agriculture, epidemiology, econometrics, public health, process control, medicine, and manufacturing, have employed ZIP distribution. Bohning et al. (1999), Lambert (1992), and Yang et al. are a few publications that use ZIP distribution (2011). Sim and Lim discuss the creation of control charts using the ZIP distribution (2008). In McLachlan and Peel, several theoretical elements of ZIP distributions are discussed (2000). Latha and Palanisamy (2018) have detailed the procedure and table for design and selection of chain sampling Plan with Zero - Inflated Poisson Distribution. Loganathan and Shalini (2013) developed single sampling plans by characteristics under the condition of ZIP distribution. Method and tables for building and choosing a Modified Chain Sampling Plan with Zero-Inflated Poisson Distribution have been discussed by Latha and Palanisamy in 2019.

The Multiple Deferred State Sampling Plan (0,2)

The Multiple Deferred State Sampling Plan (0,2) is a statistical quality control method used in manufacturing and production processes to determine whether a batch of products meets certain quality standards. In this plan, the batch is divided into multiple subgroups or lots, and each subgroup is inspected using a sampling procedure. The (0,2) notation indicates that no defects are allowed in the first sample of each subgroup, and if one or more defects are found in the first sample, a second sample is taken. If two or more defects are found in the combined samples, the entire subgroup is rejected. This plan is called "deferred state" because the decision to accept or reject the subgroup is not made until the second sample is taken, if necessary. This allows for a more accurate assessment of the quality of the batch and reduces the likelihood of rejecting a subgroup that may meet the required standards.

Operating Procedure for MDS (0, 2) Plan

The MDS (C_1, C_2) stands for the Multiple Deferred State Sampling Plan with two sampling stages, where C_1 and C_2 are the acceptance numbers for the first and second sampling stages, respectively. Here is the operating procedure for this plan:

1. Divide the batch into subgroups or lots, and randomly select a sample from each subgroup for inspection. The sample size for both stages is fixed in advance.
2. In the first sampling stage, inspect the sample for any defects or non-conformities. If no defects are found, the subgroup is accepted. If one or more defects are found, proceed to the second stage.
3. In the second sampling stage, take a second sample of the same size as the first sample from the subgroup. Inspect this second sample for any defects or non-conformities.
4. If the combined number of defects found in the first and second samples is less than or equal to C_1, the subgroup is accepted. If the combined number of defects is greater than C_1 but less than or equal to C_2, the decision is deferred, and a third sample is taken.
5. In the third sampling stage, take a third sample of the same size as the first two samples from the subgroup. Inspect this third sample for any defects or non-conformities.

6. If the combined number of defects found in the first, second, and third samples is less than or equal to C_2, the subgroup is accepted. If the combined number of defects is greater than C_2, the subgroup is rejected.
7. Repeat this process for each subgroup or lot in the batch.

The MDS (C_1, C_2) plan provides a balance between the cost of inspecting many samples and the risk of accepting a batch with poor quality. By allowing for multiple sampling stages, this plan provides a more accurate assessment of the quality of the batch and reduces the likelihood of rejecting a subgroup that may meet the required standards.

Operating Procedure for MDS (0, 2) Plan
A multiple deferred state sampling plan of Worth am and Baker (1979) with $C_1 = 0$ and $C_2 = 2$ is operated as follows:
 ➢ From each lot, take a random sample of n units and observe the nonconforming units, d.
 ➢ If d = 0, accept the lot; if d > 1, reject the lot.
 ➢ If d = 1, accept the lot, provided the forthcoming m lots in succession are all accepted (previous m lots in case of multiple dependent state sampling).
 ➢ The OC function of the MDS (0.1) plan is given by the equation

Pa (p) = P_{C1} + [P_{C2}- P_{C1}] [P_{C1}]^m

where

P_{C1} = $\varphi + (1-\varphi)\,e^{-np}$,

P_{C2}= $\varphi + (1-\varphi)\,e^{-np}$) + $(1-\varphi)\,e^{-np}\, np$

Operating Characteristic function for Multiple Deferred Sampling MDS (0,2) Plan with ZIP Model
The OC function is defined as
$$P_a(p) = P[X \leq c]$$
Where "p" is the probability of fraction defective.

The numbers of defects are zero for many samples there may consider Zero – inflated Poisson probability distribution. The probability mass function of the ZIP (φ, λ) distribution is given by Lambert (1992) and McLachlam and peel (2000)
$$P\big(X = x\,\big|\varphi, \lambda\,\big) = f(x)\ + (1 - \varphi)\, P(X = x|\lambda)$$
where

$$f(x) = \begin{cases} 1, & if\ x = 0 \\ 0, & if\ x \neq 0 \end{cases}$$

and

$$P(X = x\,/\,np) = \frac{e^{-np}\ (np)^x}{x!}, \qquad \text{when x =0, 1, 2, …}$$

The probability mass function can also be expressed as

$$P(X = x\,|\varphi, np\,) = \begin{cases} \varphi + (1-\varphi)\,e^{-np} & when\quad x = 0 \\[2mm] (1-\varphi)\dfrac{e^{-np}\,(np)^x}{x!}, & when\quad x = 1,2,…,0 < \varphi < 1,\ \lambda > 0 \end{cases}$$

In this distribution, φ may be called as the mixing proportion. φ and $(n\,p)$ are the parameters of the ZIP distribution. According to McLachlan and Peel (2000), a Zip distribution is a special kind of mixture distribution.

The probability of acceptance for Multiple Deferred State Sampling MDS (0,1) Plan based on Zero-inflated Poisson distribution. $P_a(p) = (\varphi + (1-\varphi)\,e^{-np}\ ) + (1-\varphi)\,e^{-np}\, np)\ (\varphi + (1-\varphi)\,e^{-np}\ )^m$

Average Outgoing Quality (AOQ) for Multiple Deferred State Sampling MDS (0,1) Plan with ZIP Model

For the Multiple Deferred State Sampling Plan with Zero- inflated Poisson distribution. Average Outgoing Quality (AOQ) is approximately obtained by.

$$\text{AOQ} = p\, P_a\,(p)$$

Which implies

$$n\text{AOQ}= np\,(\varphi +(1-\varphi)\,e^{-np}\,)+(np)^2\,e^{-np}\,(1-\varphi)\,(\varphi +(1-\varphi)\,e^{-np}\,)^m$$

Differentiating AOQ with respect to *np* and equating to *0*, the value of Average Outgoing Quantity Limit (AOQL) can be obtained by solving the equation.

$$(\varphi +(1-\varphi)\,e^{-np}\,)\,(1-np)-m\,(np)^2\,(1-\varphi)^2\,e^{-2np}\,)\,(\varphi +(1-\varphi)\,e^{-np}\,)^{m-1}$$
$$+\,(np)\,e^{-np}\,(1-\varphi)\,(\varphi +(1-\varphi)\,e^{-np}\,)^m\,(2-np)\qquad =0$$

From Equation (5) the values of *n p (=n p$_m$)* can be calculated for different values of φ and *i*. Substituting *n p$_m$* in equation (4) n AOQL values are obtained.

OC curves for n = 800, m = 1,2,3 and φ = 0.0001 and constructed and given in Figure 1.

Figure 2: gives AOQ curves for MDS (0,1) with ZIP n = 800, m = 1,2,3 and φ = 0.0001.

Selection Procedure of Multiple Deferred State Sampling MDS (0,2) Plan with Zip Model

This section presents procedures and tables for the construction of Multiple Deferred State Sampling MDS (0,2) Plan with Zip Model and for selection of plans by specified properties. This section provides a method for the selection of Multiple Deferred State Sampling MDS (0,2) Plan with Zip Model based on different combinations of entry parameter, Tables for determining the associated AQL and AOQL are also given. Table 5.2.1 is constructed for the selection of Multiple Deferred State Sampling MDS (0,2) plan with ZIP given φ, the parameter of Zero inflated Poisson distribution and for the required AOQL. Such table can be extended for any value of φ and AOQL. For example when AOQL of 2.5 percentage $\varphi = 0.09$ the following (n, φ, m) are obtained as(18,1),(17,2),(16,3),(18,4), (18,5), (18,6), (18,7), (18,8) or (18,9) one of which may be chosen according to the requirement of inspection.

Selection Procedure Based on Multiple Deferred State Sampling MDS (0, 2)
Plan with ZIP Model Based On AOQL and AQL

Table 5.2.2 is constructed for the selection of ZIP Multiple Deferred State sampling MDS (0,2) plan for the given value of AOQL and AQL. For given values AQL and AOQL the ratio AOQL/AQL are obtained. The sample size n is obtained and hence a combination (φ,n, m) for given AOQL and AQL for the ZIP multiple deferred state sampling MDS (0,2) plan is obtained. For example, when AOQL =0.1 and AQL=0.05, the table values closer to the ratio AOQL/AQL=2 is obtained as 2.05076for which (φ .m) =(0.05,2) and 2.32171,for which (φ .m) = (0.09,2).Similarly more combination of (φ,m) can be formed as per the inspection.

Construction of AQL / AOQL Table

In Table 5.1.3, values of *np$_1$* have been calculated for p$_1$ defined as AQL such that P$_a$(p) = 0.95. The n AOQL values and the ratio AOQL/AQL are given. For example, given that AQL=0.15 percent and AOQL is 0.25 percent, then (AOQL/AQL) = 1.666. From table 5.1.3, the values closer to this is 1.66375 which corresponding to a value of φ = 0.05 with m = 1, np$_1$ = 0.1714. Hence np$_1$ / p$_1$ = 0.1714/ 0.0015 = 114.26, i.e., about 114. Thus, the Multiple Deferred State Sampling MDS (0,1) plan. Given AQL=0.05 percent and AOQL = 0.1 percent is given by n = 271, φ = 0.05 and m = 2.

In similar manner, Multiple Deferred State sampling MDS (0,2) plan can be constructed for a wide range of AQL and AOQL values as in the given table.

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CONCLUSION

The selection of the MDS (0,2) plan with ZIP for quality level is the major focus of our work in this article. Average Outgoing Quality Level (AOQL) mathematical modeling is completely derived and examined. It has been demonstrated that the ZIP distribution is beneficial for predicting the results of manufacturing processes that result in many defect-free goods. The multivariate ZIP model can be helpful to detect specific process equipment issues and to simultaneously minimize various sorts of defects when there are multiple types of faults. A ZIP distribution is the ideal probability distribution for the number of defects per unit in a well-monitored production process where non-defects are more common. These strategies give customers reassurance about the quality of the lot following the inspection or the quality of the incoming goods. So, one may suggest this kind of sample designs for improved quality control procedures. The quality control professionals will find this approach more helpful in meeting customer demands.

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Table 1: np values for Multiple Deferred State Sampling MDS (0, 2) plan with ZIP for given Probability of Acceptance

φ	m	Pa(p)						
		0.99	**0.95**	**0.90**	**0.50**	**0.10**	**0.05**	**0.01**
	1	0.1092	0.2488	0.3714	1.1450	2.6603	3.2747	4.7269
	2	0.0751	0.1793	0.2696	0.8900	2.3484	3.0138	4.5470
	3	0.0642	0.1498	0.2248	0.7919	2.2998	2.9801	4.5631
	4	0.0539	0.1292	0.1991	0.7440	2.2969	2.9817	4.5682
0.0001	5	0.0486	0.1187	0.1814	0.7198	2.2969	2.9824	4.5697
	6	0.0430	0.1106	0.1698	0.7069	2.2969	2.9826	4.5702
	7	0.0402	0.1025	0.1603	0.7014	2.2970	2.9827	4.5703
	8	0.0345	0.0968	0.1517	0.6976	2.2970	2.9827	4.5703
	9	0.0296	0.0919	0.1461	0.6956	2.2970	2.9827	4.5703
	1	0.1139	0.2496	0.3712	1.1477	2.6654	3.2968	4.8247
	2	0.0851	0.1799	0.2702	0.8908	2.3571	3.0373	4.8247
	3	0.0662	0.1489	0.2257	0.7919	2.3067	3.0208	4.8247
	4	0.0559	0.1308	0.2009	0.7438	2.3067	3.0208	4.8247
0.001	5	0.0509	0.1187	0.1826	0.7204	2.3067	3.0208	4.8247
	6	0.0450	0.1097	0.1700	0.7078	2.3067	3.0208	4.8247
	7	0.0412	0.1027	0.1604	0.7007	2.3067	3.0208	4.8247
	8	0.0365	0.0972	0.1529	0.6977	2.3067	3.0208	4.8247
	9	0.0306	0.0927	0.1467	0.6977	2.3067	3.0208	4.8247
	1	0.1258	0.2510	0.3748	1.1645	2.7800	3.5274	7.5349
	2	0.1148	0.1814	0.2727	0.9047	2.4416	3.2355	7.5349
	3	0.1046	0.1508	0.2283	0.8030	2.4028	3.2031	7.5349
	4	0.8868	0.1320	0.2018	0.7538	2.4028	3.2031	7.5349
0.01	5	0.7767	0.1199	0.1844	0.7300	2.4028	3.2031	7.5349
	6	0.6562	0.1107	0.1717	0.7172	2.4028	3.2031	7.5349
	7	0.5673	0.1037	0.1620	0.7100	2.4028	3.2031	7.5349
	8	0.4678	0.0981	0.1543	0.7069	2.4028	3.2031	7.5349
	9	0.4478	0.0935	0.1482	0.7069	2.4028	3.2031	7.5349
	1	0.1526	0.2638	0.3934	1.2501	3.5059	8.1613	8.1613
	2	0.1462	0.1897	0.2857	0.9661	3.0143	8.1613	8.1613
	3	0.1388	0.1576	0.2390	0.8551	2.9506	8.1613	8.1613
	4	0.1286	0.1380	0.2112	0.8018	2.9506	8.1613	8.1613
0.05	5	0.1162	0.1252	0.1929	0.7761	2.9506	8.1613	8.1613
	6	0.1086	0.1156	0.1796	0.7621	2.9506	8.1613	8.1613
	7	0.0976	0.1083	0.1694	0.7546	2.9506	8.1613	8.1613
	8	0.0925	0.1029	0.1614	0.7511	2.9506	8.1613	8.1613
	9	0.0908	0.0977	0.1549	0.7511	2.9506	8.1613	8.1613
	1	0.1673	0.2740	0.4116	1.3468	5.5755	9.7696	9.9865
	2	0.1476	0.1987	0.3000	1.0370	4.6766	9.5986	9.8756
0.09	3	0.1378	0.1650	0.2508	0.9147	4.6298	9.5986	9.7895
	4	0.1165	0.1445	0.2215	0.8566	4.5835	9.5986	9.7895
	5	0.0979	0.1311	0.2023	0.8286	4.5835	9.5986	9.7895
	6	0.0924	0.1210	0.1882	0.8136	4.5835	9.5986	9.7895

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7	0.0888	0.1133	0.1775	0.8055	4.5835	9.5986	9.7895
8	0.0785	0.1072	0.1691	0.7995	4.4593	9.5986	9.7895
9	0.0743	0.1072	0.1691	0.7995	4.4593	9.5986	9.7895

Table 2: Values of np_1, φ and m for construction Multiple Deferred State Sampling MDS(0,2) plan, whose OC curve is required to pass Through the Two points (p_1 , $1-\alpha$) and (p_2 , β)

		Values of p₂/p₁ for			
φ	m	$\alpha = 0.05$ $\beta = 0.10$	$\alpha = 0.05$ $\beta = 0.05$	$\alpha = 0.05$ $\beta = 0.01$	np_1
0.0001	1	10.6914	13.1606	18.9968	0.2488
	2	13.0994	16.8109	25.3629	0.1793
	3	15.3499	19.8901	30.4555	0.1498
	4	17.7833	23.0856	35.3689	0.1292
	5	19.3510	25.1267	38.5000	0.1187
	6	20.7690	26.9687	41.3236	0.1106
	7	22.4157	29.1071	44.6006	0.1025
	8	23.7268	30.8097	47.2096	0.0968
	9	24.9869	32.4460	49.7169	0.0919
0.001	1	10.6801	13.2099	19.3321	0.2496
	2	13.0988	16.8788	26.8119	0.1799
	3	15.4937	20.2901	32.4061	0.1489
	4	17.6398	23.1007	36.8950	0.1308
	5	19.4275	25.4418	40.6341	0.1187
	6	21.0308	27.5414	43.9875	0.1097
	7	22.4535	29.4045	46.9631	0.1027
	8	23.7327	31.0797	49.6387	0.0972
	9	24.8954	32.6023	52.0704	0.0927
0.01	1	11.0768	14.0547	30.0228	0.2510
	2	13.4627	17.8400	41.5466	0.1814
	3	15.9374	21.2457	49.9775	0.1508
	4	18.1968	24.2575	57.0625	0.1320
	5	20.0440	26.7199	62.8550	0.1199
	6	21.6990	28.9262	68.0448	0.1107
	7	23.1675	30.8838	72.6498	0.1037
	8	24.4879	32.6440	76.7905	0.0981
	9	25.6880	34.2439	80.5540	0.0935
0.05	1	13.2921	30.9425	30.9425	0.2638
	2	15.8941	43.0332	43.0332	0.1897
	3	18.7243	51.7911	51.7911	0.1576
	4	21.3846	59.1493	59.1493	0.1380
	5	23.5611	65.1695	65.1695	0.1252
	6	25.5215	70.5918	70.5918	0.1156
	7	27.2405	75.3466	75.3466	0.1083
	8	28.6758	79.3166	79.3166	0.1029
	9	30.2081	83.5549	83.5549	0.0977
0.09	1	20.3481	35.6546	36.4463	0.2740

2	23.5367	48.3081	49.7024	0.1987
3	28.0534	58.1600	59.3170	0.1650
4	31.7276	66.4418	67.7635	0.1445
5	34.9660	73.2235	74.6801	0.1311
6	37.8657	79.2959	80.8733	0.1210
7	40.4391	84.6849	86.3695	0.1133
8	41.5929	89.5287	91.3097	0.1072
9	41.5929	89.5287	91.3097	0.1072

Table 3: Parameter values of Multiple Deferred State Sampling MDS (0,2) plan with ZIP Model

φ	m	np_1	np_2	np_m	n AOQL	p_2/p_1	$AOQL/p_1$
0.0001	1	0.2488	1.1450	14.4797	0.0016	4.6018	0.00643
	2	0.1793	0.8900	14.4789	0.0016	4.9644	0.00892
	3	0.1498	0.7919	14.4789	0.0016	5.2854	0.01068
	4	0.1292	0.7440	14.4789	0.0016	5.7607	0.01239
	5	0.1187	0.7198	14.4789	0.0016	6.0639	0.01348
	6	0.1106	0.7069	14.4789	0.0016	6.3922	0.01447
	7	0.1025	0.7014	14.4789	0.0016	6.8451	0.01561
	8	0.0968	0.6976	14.4789	0.0016	7.2055	0.01653
	9	0.0919	0.6956	14.4789	0.0016	7.5667	0.01741
0.001	1	0.2496	1.1477	11.7408	0.0129	4.5988	0.05169
	2	0.1799	0.8908	11.7348	0.0129	4.9502	0.07169
	3	0.1489	0.7919	11.7348	0.0129	5.3192	0.08665
	4	0.1308	0.7438	11.7348	0.0129	5.6882	0.09865
	5	0.1187	0.7204	11.7348	0.0129	6.0673	0.10865
	6	0.1097	0.7078	11.7348	0.0129	6.4532	0.11761
	7	0.1027	0.7007	11.7348	0.0129	6.8209	0.12557
	8	0.0972	0.6977	11.7348	0.0129	7.1785	0.13272
	9	0.0927	0.6977	11.7348	0.0129	7.5302	0.13922
0.01	1	0.2510	1.1645	8.8575	0.1014	4.6398	0.40403
	2	0.1814	0.9047	8.8128	0.1009	4.9882	0.55635
	3	0.1508	0.8030	8.8124	0.1009	5.3261	0.66925
	4	0.1320	0.7538	8.8123	0.1009	5.7086	0.76413
	5	0.1199	0.7300	8.8123	0.1009	6.0895	0.84169
	6	0.1107	0.7172	8.8123	0.1009	6.4767	0.91119
	7	0.1037	0.7100	8.8123	0.1009	6.8458	0.97286
	8	0.0981	0.7069	8.8123	0.1009	7.2046	1.02831
	9	0.0935	0.7069	8.8123	0.1009	7.5577	1.07870
0.05	1	0.2638	1.2501	6.6582	0.4043	4.7396	1.53285
	2	0.1897	0.9661	6.4981	0.3951	5.0943	2.08330
	3	0.1576	0.8551	6.4892	0.3947	5.4262	2.50475
	4	0.1380	0.8018	6.4887	0.3946	5.8108	2.85989
	5	0.1252	0.7761	6.4887	0.3946	6.1970	3.15097
	6	0.1156	0.7621	6.4887	0.3946	6.5922	3.41314
	7	0.1083	0.7546	6.4887	0.3946	6.9666	3.64304
	8	0.1029	0.7511	6.4887	0.3946	7.2998	3.83499
	9	0.0977	0.7511	6.4887	0.3946	7.6898	4.03991
0.09	1	0.2740	1.3468	5.7350	0.6685	4.9153	2.43973

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2	0.1987	1.0370	5.4957	0.6307	5.2192	3.17422
3	0.1650	0.9147	5.4703	0.6282	5.5425	3.80642
4	0.1445	0.8566	5.4677	0.6279	5.9293	4.34636
5	0.1311	0.8286	5.4675	0.6279	6.3214	4.78999
6	0.1210	0.8136	5.4674	0.6279	6.7213	5.18722
7	0.1133	0.8055	5.4674	0.6279	7.1063	5.53975
8	0.1072	0.7995	5.4674	0.6279	7.4568	5.85662
9	0.1072	0.7995	5.4674	0.6279	7.4568	5.85662

Table 4: Value of sample size for given AOQL, φ and m

		AOQL in Percent																	
φ	m	0.10	0.25	0.50	0.75	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	6.0	7.0	8.0	9.0	10.0
	1	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	2	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	3	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	4	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.0001	5	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	6	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	7	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	8	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	9	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1	13	5	3	2	1	1	1	1	0	0	0	0	0	0	0	0	0	0
	2	13	5	3	2	1	1	1	1	0	0	0	0	0	0	0	0	0	0
	3	13	5	3	2	1	1	1	1	0	0	0	0	0	0	0	0	0	0
	4	13	5	3	2	1	1	1	1	0	0	0	0	0	0	0	0	0	0
0.001	5	13	5	3	2	1	1	1	1	0	0	0	0	0	0	0	0	0	0
	6	13	5	3	2	1	1	1	1	0	0	0	0	0	0	0	0	0	0
	7	13	5	3	2	1	1	1	1	0	0	0	0	0	0	0	0	0	0
	8	13	5	3	2	1	1	1	1	0	0	0	0	0	0	0	0	0	0
	9	13	5	3	2	1	1	1	1	0	0	0	0	0	0	0	0	0	0
	1	101	41	20	14	10	7	5	4	3	3	3	2	2	2	1	1	1	1
	2	101	40	20	13	10	7	5	4	3	3	3	2	2	2	1	1	1	1
	3	101	40	20	13	10	7	5	4	3	3	3	2	2	2	1	1	1	1
	4	101	40	20	13	10	7	5	4	3	3	3	2	2	2	1	1	1	1
0.01	5	101	40	20	13	10	7	5	4	3	3	3	2	2	2	1	1	1	1
	6	101	40	20	13	10	7	5	4	3	3	3	2	2	2	1	1	1	1
	7	101	40	20	13	10	7	5	4	3	3	3	2	2	2	1	1	1	1
	8	101	40	20	13	10	7	5	4	3	3	3	2	2	2	1	1	1	1
	9	101	40	20	13	10	7	5	4	3	3	3	2	2	2	1	1	1	1
	1	404	162	81	54	40	27	20	16	13	12	10	9	8	7	6	5	4	4
0.05	2	395	158	79	53	40	26	20	16	13	11	10	9	8	7	6	5	4	4
	3	395	158	79	53	39	26	20	16	13	11	10	9	8	7	6	5	4	4
	4	395	158	79	53	39	26	20	16	13	11	10	9	8	7	6	5	4	4

	5	395	158	79	53	39	26	20	16	13	11	10	9	8	7	6	5	4	4
	6	395	158	79	53	39	26	20	16	13	11	10	9	8	7	6	5	4	4
	7	395	158	79	53	39	26	20	16	13	11	10	9	8	7	6	5	4	4
	8	395	158	79	53	39	26	20	16	13	11	10	9	8	7	6	5	4	4
	9	395	158	79	53	39	26	20	16	13	11	10	9	8	7	6	5	4	4
	1	669	267	134	89	67	45	33	27	22	19	17	15	13	11	10	8	7	7
	2	631	252	126	84	63	42	32	25	21	18	16	14	13	11	9	8	7	6
	3	628	251	126	84	63	42	31	25	21	18	16	14	13	10	9	8	7	6
	4	628	251	126	84	63	42	31	25	21	18	16	14	13	10	9	8	7	6
0.09	5	628	251	126	84	63	42	31	25	21	18	16	14	13	10	9	8	7	6
	6	628	251	126	84	63	42	31	25	21	18	16	14	13	10	9	8	7	6
	7	628	251	126	84	63	42	31	25	21	18	16	14	13	10	9	8	7	6
	8	628	251	126	84	63	42	31	25	21	18	16	14	13	10	9	8	7	6
	9	628	251	126	84	63	42	31	25	21	18	16	14	13	10	9	8	7	6

Table 5: Selection procedure based on AQL and AOQL

AQL in %		AOQL %	
		0.1	0.25
	φ	n, m	n, m
0.05	0.05	395,2	
	0.09		251,6
0.75	0.05	404,1	158,6
	0.09		251.3
0.10	0.01	101,7	
	0.01	101,8	
	0.05		158,3
	0.09		267,1
0.15	0.01	13,3	
	0.05		158,2
0.20	0.01	395,2	
	0.05		158,2
0.25	0.01	101,4	40, 8
			40,9
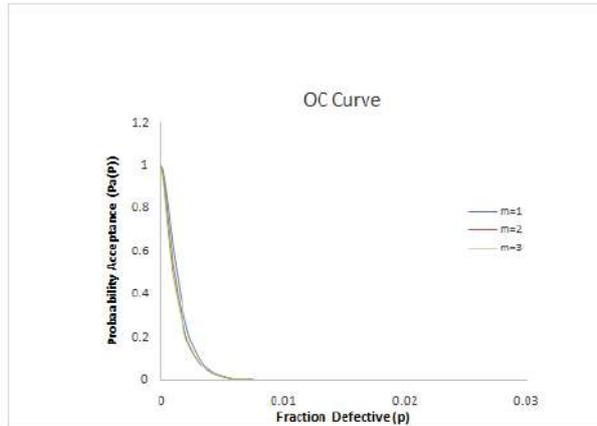
Figure 1: OC Curve for MDS (0, 2) with ZIP   n = 800, m = 1,2,3 and $\varphi = 0.0001$, through specified parametric values.
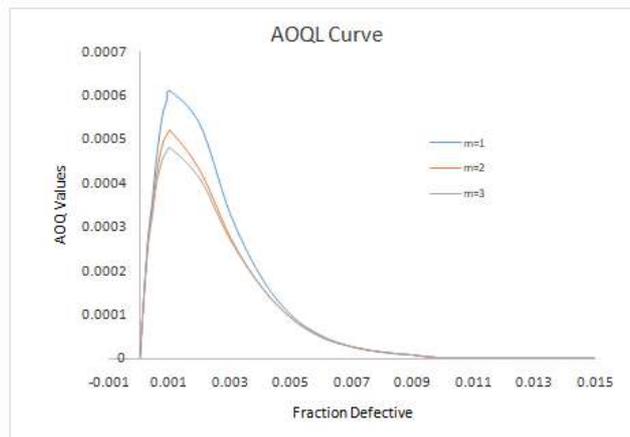
Figure 2: AOQ curves for MDS (0, 2) with ZIP n = 800, and m = 1, 2,3.and $\varphi = 0.0001$, through specified parametric values.

RESEARCH ARTICLE

Covid-19 Anxiety and Quality of Sleep : A Cross-Sectional Investigation

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ABSTRACT

Sleep plays a vital role in maintaining psychological well-being in individuals. The objective of the study is to explore the impact of anxiety related to the COVID-19 pandemic on the quality of sleep. In this cross-sectional research, various standardized measures were implemented to evaluate COVID-19 anxiety and sleep quality among a sample of eighty-five young adults. Statistical analysis involved the use of t-tests and correlation techniques. The research employed a snowball sampling approach. The study aimed to uncover the association between COVID-19 anxiety and sleep quality. The findings indicate that COVID-19 anxiety has had an adverse effect on sleep quality, especially among women as compared to men. In addition, the research emphasizes mitigating various interventions such as mindfulness and adhering to daily routines as potential strategies to enhance sleep quality and alleviate COVID-19 anxiety.

Keywords: Sleep, Stress, health, sleep disorders, mental health

INTRODUCTION

COVID-19 (Corona virus disease)is an illness of the lungs that emerged in an outbreak in December 2019 and progressed to pose a global pandemic. Nowadays and worldwide, the focus has shifted to COVID-19and its consequences on mental health. Recognizing the anxiety level among adults and its effects on sleep quality is essential. World Health Organization (WHO), on January 30th, 2020, declared this disease a public health emergency and later declared it a pandemic. Sleep plays an integral role in health. Getting quality sleep is as essential as food and water. Sleep affects almost every body system, such as our mood, immune system, brain, heart, lungs, and ability to function efficiently. This investigation carries a positive outlook while studying variables like COVID-19 anxiety and sleep quality. Various types of stressors create problems in our day-to-day life. Daily problems or hassles

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are those things that make us irritated, dissatisfied, and distressed, which can cause mental strain and disrupt sleep. Some ways it can impact people's lives are feelings of isolation, nightmares, change in appetite, energy, fear, worry, sadness, more screen time, and worsening of psychological conditions. Mornin et al. (2020) state that ample sleep is necessary to maintain good physical health and proper immune system functioning. Sleep is a fundamental physiological and behavioral state characterized by unconsciousness, minimal physical activity, and reduced responsiveness to external stimuli. The state is connected to circadian rhythms and intricate internal processes. In humans, the hypothalamus contains the SCN (suprachiasmatic Nucleus)often referred to as the "biological clock". Which regulates the release of melatonin and plays a role in facilitating sleep. Changes in daily activity, jet lag, and sometimes sleep disorders can disrupt circadian rhythms (Blask, 2009; Matts and Sehgal,2016). However,COVID-19 anxiety is also one of the main reasons for disrupting the circadian rhythm. In addition, various physiological changes occur while we are asleep. A) Cardiovascular: Rapid changes occur in blood pressure and heart rate while we are asleep. These are determined by autonomic nervous system activity. For example, little blood pressure and heart rate increase as large body movements. B) Respiratory: While sleeping, the respiratory flow becomes faster and more erratic, especially in REM sleep. Hypoventilation leads to deficient ventilation, which causes a reduction in oxygen and an increase in carbon dioxide in NREM sleep. Not eating proper food and lack of physical exercise causes obesity problems, eventually leading to bigger problems like increased cholesterol, high blood pressure, and digestive problems. In addition, waking up late caused them to have low motivation for their work and feel lethargic the whole day. Furthermore, engagement in activities which is tiring makes their mood irritating. It can cause sleep problems. Dwelling negative thoughts can make them feel gloomy, hampering their sleep. Furthermore, it eventually disturbs their routine. Thus, this study focuses on problems, challenges, and how to cope and have a positive outlook in difficult times.

LITERATURE REVIEW

According to Carskadon and Dement (2011), "sleep is a reversible behavioral state of perceptual disengagement from, and unresponsiveness to, the environment." Sleep is considered essential for the proper functioning of the brain and body. For example, a night of proper sleep can help in reasoning. It is also said that sufficient sleep is required for appropriate psychological well-being and the working of cognitive processes. However ,the COVID-19outbreak has worsened sleep quality among adults. After the covid-19, it has been noticed that the sleeping hours were less than 8 hours among individuals. Sleep generally aids in regulating typical and steady physiological functions such as brain maturation, memory retention, and acquiring knowledge(Abel et al.,2013). Persistent disruption in circadian rhythm can lead to a higher risk of developing diseases such as cancer, diabetes, cardiovascular diseases, and viral infections. (Almeida and Maleheiro,2016; Kecklund And Axelsson,2016). The pressure to perform well in exams among students was straining for them, which caused academic stress among them since everything got shut down. Schools and colleges everything got shifted to online mode. Furthermore, some students' parents with poor economic conditions must suffer more since they cannot get their children electronic devices so that they can attend their classes online, which causes financial and mental stress among them. It can cause various sleep disturbances among adults and can cause poor sleep quality, leading to difficulty falling asleep, waking up frequently, waking up too early, and Un-refresh sleep. The most common disorder or dysfunction is insomnia, which can cause irritability, fatigue, difficulty tolerating stress, and mood disturbances.

Monroe and Simon(1991) reported that the diathesis-stress model could describe the effect of insomnia on depression and anxiety. Those individuals developed certain diseases, for example, anxiety or depression. In this case, the stress created by insomnia might provoke anxiety and depression. Following puberty, hormonal changes could also be one of the reasons that can cause sleep disturbances, which means excessive daytime sleepiness. It had been seen typically between fifteen to twenty-five years old. Then, they abruptly enter into REM sleep. Nightmares and night terrors are the other most common dysfunction that has mostly been reported. It may require treatment if it causes lots of problems getting enough sleep. The National Sleep Foundation (2009) defined that insufficient sleep duration among adolescents is less than eight hours per day. A progressive decline in sleep quality has been observed in

many adolescents worldwide. The reason for the sleep delay is the nighttime activities that keep them awake. With new technologies, caffeine intake leads to poor quality sleep among individuals. While sleeping, dreams play a significant role. People tend to have nightmares or night terrors when anxious or stressed. Dreams are story-like sequences. It can be organized, chaotic, vivid, or bizarre. Individuals tend to remember their dreams, while some do not the following day. Also, according to the study, it has been noticed that more individual often wakes up from REM sleep. Therefore, they are more likely to remember the dream. There are various ways to measure sleep, such as EEG and an electroencephalogram, which helps to measure the electrical activity in the brain. Muscle activity is measured by electromyography (EMG).Eye movements during sleep by electro-oculo graphy(EOG),Low motivation to do work, daytime sleepiness, and getting angry about petty things can seriously affect the usual living style of an individual. For this, coping strategies have been there in which the focus should be decreasing stress and overcoming the challenges affecting everyday life.(Proud foot et al. 2004) studied randomized control therapy on demographic variables and technology-based cognitive-behavioral therapy targets anxiety and depression within primary care settings. There are different ways to cope with stress and anxiety, which affects the quality of sleep, for instance taking pauses from consuming news content whether it's through watching, reading, or engaging with stories on social media. It can upset your mood and fill your mind with negative thoughts .Improving sleep hygiene means improving sleep habits, Escaping avoidance and accepting reality**,** establishing daily routines**,** taking care of your body by eating healthy food, doing a physical workout**,** self-control, controlling yourself from the habits that can cause problems**,** an dregulating your behaviors. Thus, the present investigation examined how COVID-19 anxiety and sleep quality are interrelated among young adults in India. Furthermore, it aimed to analyze potential variations in COVID-19 anxiety and sleep quality based on the gender of the youth in India.

METHODOLOGY

In this cross-sectional study, snowball sampling has been used. A total of 85 Indian adults comprising 32 males and 50 females, formed the sample. Some responses were eliminated because they were incomplete. The age range of the participants was 17- 29 years. Socio demographic information regarding age, gender, and occupational status was collected from the participants. The study employed the COVID-19 Pandemic Anxiety Scale (COVID-19PAS; Kumar et al., 2020) and Pittsburgh Sleep Quality Index (PSQI) to evaluate COVID-19 anxiety and sleep quality. Data collection was conducted through Google Forms. The PSQI, a self-assessment tool, that gauges subjective sleep quality has self-rated inquiries divided into seven categories: sleep latency, sleep disturbance, habitual sleep efficiency, sleep duration, use of sleep medication, and daytime dysfunction. The gathered data underwent analysis using SPSS 21. Descriptive, bi variate correlation and Independent sample t-tests were computed on the collected data. To assess the magnitude of correlations, Cohen's criteria(1988) were utilized, where a score of 0.50 indicates the large effect size, 0.30 denotes the moderate effect size, and 0.10 signifies the small effect size. Cronbach's alpha was computed to evaluate the reliability of scales.

RESULTS AND DISCUSSION

The primary aim of this study was to investigate the link between COVID-19 anxiety and the sleep quality of young adults in India. Additionally, we sought to assess gender-based variations in COVID-19 anxiety and sleep quality between males and females. Our analysis revealed a significant correlation between sleep quality and COVID-19 anxiety among young adults, as shown in Table 2. This correlation table underscores a noteworthy association between these variables (Cohen, 1988). Notably, higher sleep quality scores were indicative of poorer sleep quality. Fear demonstrated a moderate correlation with somatic concerns, implying that heightened fear is linked to increased anxiety about falling ill, which can disrupt daily functioning. Fear also displayed a strong association with pandemic-related anxiety, specifically COVID-19 anxiety, highlighting how fear has contributed significantly to anxiety surrounding the pandemic. However, fear exhibited only a low correlation with subjective sleep quality, sleep latency, habitual sleep efficiency, sleep disturbance, daytime dysfunction, and the overall Pittsburgh sleep quality index (PSQI). Fear did not substantially impact these components but did contribute to some sleep-related

issues. Fear exhibited a negative correlation with sleep medication and sleep duration. As fear levels rose, medication use decreased, and sleep duration shortened. Comparatively, somatic concerns showed a highly significant association with COVID-19 anxiety and sleep quality. This suggests that the fear of contracting a potential illness and constant worry about falling sick significantly increased COVID-19 anxiety and severely affected the sleep quality of young adults. On the other hand, somatic concerns moderately influenced subjective sleep quality, sleep latency, habitual sleep efficiency, sleep disturbance, and daytime dysfunction. Concerns related to falling ill affected various aspects of sleep but did not to an extent that severely impeded daily functioning. Somatic concerns had no impact on sleep medication or sleep duration.COVID-19 anxiety moderately correlated with subjective sleep quality, habitual sleep efficiency, sleep latency, sleep disturbance, daytime dysfunction, and the Pittsburgh Sleep Quality Index (PSQI). This indicates that COVID-19 anxiety affected various facets of sleep and overall sleep quality, resulting in poorer sleep among individuals and impacting their overall well-being and daytime productivity.COVID-19 anxiety was also negatively associated with sleep duration and medication intake. As anxiety levels increased, sleep duration decreased, and reliance on sleep medication decreased. A low correlation was observed between daytime dysfunction and habitual sleep efficiency, suggesting that COVID-19 anxiety influenced these aspects but did not lead to significantly longer nighttime wakefulness while in bed.

Table 3 presented gender differences between males and females regarding anxiety and pandemic-related sleep quality. The results revealed significant disparities in fear, somatic concerns, the COVID-19 Anxiety Scale, subjective sleep quality, sleep duration, sleep disturbance, and daytime dysfunction. However, no substantial distinctions were observed between men and women in terms of sleep latency, habitual sleep efficiency, sleep medication, and sleep quality index. The findings also indicated that females exhibited higher levels of COVID-19 anxiety and poorer sleep quality compared to males. Several factors could contribute to this observation, including the fact that females typically spend more time at home, potentially leading to anxiety about the future. This research offers beneficial insights and approaches into the COVID-19 pandemic-related anxiety among young adults to address them effectively, This research raises awareness about holistic health, encompassing physical, psychological, and emotional well-being. It also serves as a guide for promoting a positive mindset, encouraging individuals to approach life challenges with optimism even during difficult times. It facilitates individuals to make productive use of their time by engaging in meaningful activities and maximizing their potential.

CONCLUSION

Based on the examination of the study of COVID-19 anxiety and sleep quality, we can deduce that a considerable association exists between COVID-19 anxiety and an individual's sleep quality. COVID-19 anxiety has profound effects on sleep quality among individuals, which has disrupted the sleep cycle and inculcated bad habits among individuals. The pandemic gave rise to stress, uncertainties, and worries about the future, which perniciously affected the quality of sleep among individuals. It has been observed that females experience higher levels of COVID-19 anxiety than males, resulting in significant disturbances in females. This research provides proper insights into the difficulties individuals face and recommends coping strategies. It accentuates the importance of health and being physically, psychologically, and emotionally fit. The findings encourage individuals to maintain a positive outlook, even in tough times, emphasizing mental and emotional strength, Moreover, it enables mental health professionals to develop strategies for addressing stress and anxiety during crises like pandemics.

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Table 1. Descriptive statistics for the study variables

Variables	Mean	SD	SEM
Fear	5.49	4.089	.452
Somatic concerns	3.44	2.982	.329
COVID-19 Anxiety	8.93	5.987	.661
Subjective Sleep Quality	1.21	.813	.090
Sleep latency	1.61	1.015	.112
Sleep duration	1.00	1.217	.134
Habitual Sleep Efficiency	.15	.419	.046
Sleep disturbance	1.40	.585	.065
Sleep medication use	.17	.517	.057
Daytime Dysfunction	1.41	.916	.101
Sleep Quality	6.95	3.142	.347

Table 2. Bivariate correlations for the study variables

		1	2	3	4	5	6	7	8	9	10
1	Fear										
2	Somatic Concerns	.420**									
3	COVID-19 Anxiety	.892**	.785**								
4	Subjective Sleep Quality	.200	.472**	.371**							
5	Sleep latency	.118	.490**	.324**	.503**						

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6	Sleep duration	-.072	.088	-.005	.050	-.120					
7	Habitual Sleep Equality	.102	.412**	.275*	.236*	.310**	.387**				
8	Sleep disturbance	.092	.478**	.301**	.394**	.413**	-.121	.160			
9	Sleeping medication	-.081	.079	-.016	.150	.152	.157	.282*	.056		
10	Daytime dysfunction	.034	.448**	.247*	.447**	.362**	.066	.322**	.353**	.110	
11	Pittsburgh Sleep Quality Index	.089	.602**	.361**	.700**	.656**	.436**	.614**	.508**	.393**	.677**

Table 3. T-test for comparing males and females on pandemic anxiety and sleep quality

Variables	Gender	N	M	SD	SEM	t	p
Fear	Male	32	3.78	2.926	.517	-3.190	.002
	Female	50	6.58	4.371	.618		
Somatic concerns	Male	32	2.25	2.243	.397	-3.001	.003
	Female	50	4.20	3.162	.447		
COVID-19 Anxiety	Male	32	6.03	4.410	.780	-3.780	.001
	Female	50	10.78	6.162	.871		
Subjective Sleep Quality	Male	32	0.97	.822	.145	-2.175	.033
	Female	50	.136	.776	.110		
Sleep latency	Male	32	1.41	1.103	.195	-1.462	.148
	Female	50	1.74	.944	.133		
Sleep duration	Male	32	1.41	1.292	.228	2.495	.015
	Female	50	.74	1.103	.156		
Habitual Sleep Efficiency	Male	32	.13	.336	.059	-.367	.715
	Female	50	.19	.468	.066		
Sleep disturbance	Male	32	1.19	.397	.070	-2.769	.007
	Female	50	1.54	.646	.091		
Sleeping medication	Male	32	.28	.729	.129	1.564	.122
	Female	50	.10	.303	.043		
Daytime dysfunction	Male	32	1.16	.847	.150	-2.086	0.040
	Female	50	1.58	.928	.131		
Pittsburgh Sleep Quality Index	Male	32	6.53	2.994	.529	-.968	.336
	Female	50	7.22	3.234	.457		

REVIEW ARTICLE

Herbal Supplements in Europe: An Overview of the Regulatory Framework

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ABSTRACT

Herbal remedies are an essential component of many primary healthcare systems across the globe. However, as these remedies become more prevalent, negative side effects and interactions with other drugs become more common, leading to increased regulatory measures. The specific laws governing the production and distribution of herbal products vary between countries, with different classifications such as functional foods, dietary supplements, and traditional medicines. Each country has its own unique set of regulations for traditional and herbal remedies. Establishing a standardized The European pharma sector, medical professionals, and patients all benefit from a robust herbal medicine market. To coordinate the manufacture and distribution of traditional herbal remedies in the European market, The Committee for Herbal Medicinal Products(HMPC) was formed. Directive 2004/24/EC, issued by the European Parliament and the Council of Europe in the year 2004, serves as the future legal basis for the therapeutic application of medicinal plants in Europe. By this Directive, all herbal medicines that are made commercially accessible must be recognized by the national regulatory agencies of every European nation and adhere to a set of accepted safety and efficacy standards.

Keywords: Herbal, Medicinal products, Traditional Medicine, European Union

INTRODUCTION

Herbal remedies have an extended history and have been utilized for decades throughout Europe. The desire to capitalize on the knowledge of traditional treatment systems has reawakened interest in herbal medicines, notably in Europe, wherein herbal products have been included in so-called "alternative," "complementary," or "integrative" medical practices. Despite several advances in technology in the manufacture of synthetic pharmaceuticals, interest in natural remedies is on the rise in Europe right now. According to statistics from the WHO, 80% of the population prefers herbal medications to treat their medical issues.(1)"Plant-derived goods or substances having medicinal properties or additional benefits for human health" are considered herbal remedies, which contain either raw material or processed ingredients from one or more plants". During a particular point, people have utilized plants to cure and safeguard themselves against different ailments. However, with the advancement of science, the utilization of Herbal Medicines (HMs) has become more widespread. (2) The considerable experience of both practitioners and patients throughout time (entire historical timeline) may be used to explain why herbal treatments have become so popular. Additionally, these medicines are generally considered to be safe for use. Each country has its regulations and laws regarding traditional and herbal medicines. Practitioners of traditional medicine around the world widely use herbal medicines due to their established efficacy. Herbal products are the most widely used kind of traditional medicine in Western Europe, according to the WHO.(3)The European Medicines Agency's Committee for Herbal Medicinal Products (HMPC) sets criteria for quality, non-clinical inquiries, clinical effectiveness, and safety. The European Union recently established legislation designating plant-based goods as medications, and other member states now accept those that meet quality standards and have been recognized by a particular member state.(4)The use of natural medicinal products has been crucial in meeting the basic healthcare needs of populations. Herbal medicines have been authorized in Europe under one of the two directives, "well-established use," or "traditional herbal medicinal products," both of which have stringent quality- and safety-related standards.(5)The well-established usage method is a streamlined registering process for herbal medical products that have been continuously in use for at least ten years, with at least five of those years spent in the EU.(6)"Traditional herbal medicinal products," enacted in 2004, enable a corporation to prove that the medicinal product has been in use for a minimum of 30 years inside the EU, or 15 years between the EU and 30 years across the EU.(7)

Herbal Medicine
Herbal medicine, also known as herbalism or phytotherapy, is a traditional medicinal practice that involves using plants and products produced by plants to mitigate various health conditions and promote overall well-being. Humans have relied on herbs for healing purposes for thousands of years, dating back to ancient civilizations. The use of different parts of plants such as leaves, flowers, stems, roots, and seeds is common in herbal medicine, as they contain various chemical compounds with potential therapeutic effects, including alkaloids, flavonoids, essential oils, tannins, and other bioactive substances. The combination of these compounds can have a synergistic effect and contribute to the plant's medicinal properties. (8,9)

History of Herbals in Europe:
Herbalism has a lengthy history in Europe, with the first mention of it happening in the first century BC in Western Europe. Bay leaf and rosemary were included in a list of savory and sacred plants used in cooking and on special occasions by the Greeks and Romans, who built on the Egyptians' usage of herbs. (10).

To heal the sick, monks in European monasteries throughout the Dark Ages copied herbal writings, maintained herb gardens, and employed herbal treatments. Because the primary purpose of the plant was as a remedy, knowledge of medieval botany was intimately tied to medical knowledge. Herbals were organized according to the names of the plants, distinguishing characteristics, medicinal plant sections, therapeutic powers, and in some cases, preparation and instruction for use. Dioscorides, a Greek physician and pharmacologist who flourished between 40 and 90 A.D., generated the first study of herbal medicine that was accepted as a medical norm in the European tradition. European herbals saw innovation and diversification during the Modern Age and Renaissance, moving away from

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being merely conventional model adaptations and towards relying more on direct observation. The advent of recent advances in the field of chemistry the study of toxicology and pharmacology reduced the medicinal efficacy of classical herbals in the latter part of the seventeenth century, and Florasystematic accounts of the plants found growing in a particular areareplaced herbs with accurate botanical terms, classifications, and representations. The EU has created rules for herbal medical goods to ensure their security and efficacy even though they have remained a significant component of healthcare in Europe.(12,13)

Challenges in Ensuring Consistency and Safety of Herbal-Based Medicines:
An additional concern that remains uncertain is the limited understanding of the composition of herbal-based medicines. Herbs are natural products, and as such, their chemical composition can differ based on several variables, including the botanical species, the portion of the plant utilized (such as a seed, flower, root, or leaf), storage conditions, exposure to sunlight and humidity, type of soil, harvesting season, and geographic location. Despite being standardized for high pharmaceutical quality, commercial goods that contain herbs might fluctuate from batch to batch in their composition and quantities of chemical ingredients.(14) Even the same manufacturer may make products over time that contain various substances. Due to this heterogeneity, there may be considerable variations in pharmacological efficacy, including problems with pharmacodynamic and pharmacokinetic drug metabolism. Therefore, it is important to ensure that there is reliable and consistent information on the composition of herbal-based treatments to avoid potential health risks.(15)

Effectiveness and Safety of a Traditional Herbal Remedy
To assess traditional herbal treatments' Quality, Effectiveness, and Safety, it is important to answer several basic questions.
1.   Is it necessary to determine which specific treatment should be studied?
2.   It must be determined whether the treatment can be studied using modern scientific protocols.
3.   Is it important to consider whether it is scientifically appropriate to directly export herbal medicine from one country to a different country?

Many aspects can impact the result of treatment(traditional),both in the laboratory and the clinic. These include the knowledge, skills, and beliefs of the sponsors, as well as the patient's attitudes towards the treatment .Cultural variations in the acceptance of the treatment and its compliance, as well as the patient-physician relationship and access to the other therapy, are also important considerations. In the era of globalization, assessing the transferability of herbal medicine treatment is not the primary objective of clinical research. Instead, effectiveness and safety should be assessed by accepted clinical medical practices.(16)

Establishment of Regulatory Standards for Herbal Medicines
The declaration of Alma-Ata was the earliest recognition of herbal remedy's importance and use in basic healthcare on a worldwide scale. It states, "Primary medical treatment relies on medical professionals, including nurses, doctors, midwives and other assistants, and community service providers as appropriate, as well as conventional healers as needed".(17)Lack of strong regulations for safety evaluation, effectiveness, monitoring the quality, and understanding of traditional medicine/complementary and alternative medicine (TM/CAM) and ineffective quality control are major issues found in various regulatory systems. Plant-based products may be categorized differently under different regulatory systems, including food, functional food, supplements, or herbal remedies. Herbal medications consist of active ingredients derived from plant parts, other materials of plants, or their mixtures, while the European Medicines Agency (EMEA) defines herbal medicines as unprocessed plants,plant parts, fungi, lichen, algae, and exudates.(18) European Directive 2004/24/EC (Major legislation or Guidance documents)-The EU's legal framework for the marketing and sale of traditional herbal medicinal products is set down in European Directive 2004/24/EC, also referred to as the Traditional Herbal Medicinal Products Directive. The regulation strives to guarantee the effectiveness, security, and purity of such items while permitting their ongoing use based on historical usage.(19) The term *"herbal drug preparations"* refers to herbal medications that have undergone the extraction process, the process of distillation fractionation, cleansing, concentration, or fermentation, products, like retrieved juice, tinctures, essential oils, expressed juice, or processing exudates, can be produced or processed traditional

medications. The unregulated and growing market for herbal medicinal products is leading to safety issues due to these inconsistencies in regulation and quality control.(20)

Formation/Creating EU Committee for Herbal Medicines
The HMPC was created in Europe for the European Medicines Agency in September 2004 in London. This Committee was established to harmonize the manufacture & trade of the traditional herbal remedy in the European market. The HMPC committed to issue or publish the monographs and guidelines related to" remedies derived from herbs and plants for medicinal purposes.".(21) The HMPC comprises 33 members out of which 28 members represent the EU and one each from Norway & Iceland (EEA-EFTA states). The remaining five members of HMPC represent different domains of science. The Herbal Medicinal Product(HMP) functions in collaboration with "The European Directorate for the Quality of Medicines & HealthCare." (EDQM)and various scientific authorities in Europe and around the world. The scientific experts of the European Commission, EU candidates such as Montenegro, Serbia, Albania, Bosnia, FYROM, Herzegovina, Kosovo Turkey, and EDQM take part in different meetings of HMPs as official observers. On 26 April 2007, the French regulation (Ordinance no. 2007613) implemented the Directive 2004/24 which demonstrated that the HMPC was mainly responsible for the evaluation, registration & authorization for the herbal products. The French Directive 2004/24 further amended the law in Directive 2001/83/EC, which allows the marketing of various therapeutic products only after regulatory parameters concerned with quality, safety, and efficacy.(22)

European Regulations and Guidelines
By European Directive 2001/83/EC, the effectiveness, quality, and safety results of certain assessments, and experimental findings are taken into account when issuing marketing authorization for herbal medical products. The Directive 2001/83/EC specifies standards for conventional herbal medicine, a list of commonly used herbal ingredients, herbal product monographs, and requirements for a streamlined registration procedure.(23)The HMPC, a branch of EMA, was created concerning EU Regulation No 726/2004 and European Directive 2004/24/EC (2004, Sep). The majority of herbal product manufacturers experienced multiple obstacles while attempting to comply with European Directive 2004/24/EC's simplification of the registration process while also meeting the standards of Directive 2001/83/EC for efficacy in specific. (24)

To overcome such difficulties
The "Traditional Herbal Medicinal Products Directive" (THMPD); 2004/24/EC) is Traditional Herbal Medicinal Products Directive is an important component of the law governing produced products made from herbs, was established by the EU in 2004. A preliminary transition phase existed, and it concluded across the EU in 2014. The THMPD imposed strict rules on the importation and sale of commercially manufactured herbal medicine products and enforced the registration of all such items in one of the three categories. They can first be registered with a Product Licence by following the same legal processes as medicines. (25)This demands pharmacokinetic data from research studies that indicate effectiveness, which is practically impossible for herbal medicines that frequently comprise a lot of components. Second, when there have been at least ten years of established use in the EU with recognized efficacy and a tolerated safety profile, the Well Established Use regulation may be used. A different method for registering items is the Traditional Use Registration (TUR) process. The prerequisites for a TUR include verification of:

- Conventional use for a minimum of three decades, of which 15 years must be spent in the EU, for the indicated indications(23)
- The ingredients' quality satisfies European requirements
- An assessment of the product's safety conducted by a registered medical professional, chemist, "scientifically qualified" expert (such as a toxicologist), or herbalist who belongs to a professional organization.
- TUR materials must be marked or labeled with the phrases "A traditional herbal medicinal product" and "based on traditional use only" from beginning to end. A thorough Health Information Leaflet must be provided.

A herbalist has been permitted by UK law to meet with specific patients, make diagnoses, and produce herbal remedies on their premises, provided that they do not contain any forbidden or restricted components. It falls under

the "herbalist exemption" of The Human Medicine Regulations 2012, Regulation 3. This remains the same regardless of training or prior work experience, and the THMPD. (26)

Quality, Safety, Effectiveness, and Post-Sale Monitoring For Herbal Products in the EU
Quality Requirements
Unlike conventional medicines, which are usually single biological or chemical entities, herbal drugs consist of blended composites containing multiple ingredients. These constituents are often poorly understood, and standardization can be difficult due to the unknown active principles responsible for the medicinal effects. Additionally, the variability of plant constituents can be influenced by environmental conditions and agricultural practices. As a result, quality requirements for herbal medicines can be more challenging to establish and maintain compared to conventional medicines.(27)

Herbal Medicinal Products(HMP)
Herbal products should meet the same pharmaceutical quality requirements as other therapeutic products, adhering to rules for excellent industrial practices, appropriate farming and collecting practices, etc. To confirm safety, quality, and efficacy the initial application for an HMP should include The above-mentioned requirements are necessary to maintain the quality and safety of HMPs throughout their manufacturing process. Moreover, the application for the finished herbal medicinal product should also include a description of the components used to produce the therapeutic product, controls for the finished product's uniformity and the accuracy of the methods of analysis used to assess the product's quality, and stability controls to ensure the product's shelf life. To obtain a comprehensive list of requirements for producing herbal medicinal products, it is essential to refer to the Directive 2003/63/EC Directive and additional guidelines issued by the EMA. These guidelines provide detailed information on the production, quality, and herbal medicinal products safety and are essential for confirming that these products meet the necessary standards for human use.(28)

Safety and Efficacy
There is often a range of evidence available for herbal medicines/products, which may be limited. Furthermore, information about these products is typically assessed from varying perspectives and filtered through differing opinions based on experimental or conventional practice with different types of general medicines in different countries. Conventional toxicological and pharmacological studies or clinical trial findings are not necessarily necessary for the traditional utilization of natural medicinal products due to their extensive history of usage, except for genotoxicity. Although some herbal medicines can undergo rigorous clinical trials, the current regulatory framework does not incentivize manufacturers to do so. As a result, there is an inadequate of reliable information about the health risks of many herbal medications, proposing problems regarding assessment of their effectiveness based on evidence-based medicine criteria.(29) Even though many individuals believe that medicines made from herbs are safe because of their origins in nature and long heritage of usage, well-controlled clinical studies and reports of cases have demonstrated that they can have undesirable side effects. Herbal medicines should be used with caution in certain patient populations, such as those with HIV-AIDS, pregnant or breastfeeding women, children, and the elderly, as well as when used in combination with conventional medicines. Careful consideration is necessary in these situations. The EU herbal monographs offer all the necessary details for using medications that contain herbal ingredients or mixtures. This information is based on nonclinical and scientific information, historic use, and experience both inside the EU and, if accessible, elsewhere within it. The two sections of the monographs are well-established usage and conventional use. The monograph is employed to develop the necessary details about the product, such as the packaging leaflets and the summary of product features.(30) The applications for established herbal remedies must follow standard clinical conditions requiring a medical assessment by 2004/24/EC(Directive). In other words, herbal medicinal products can only indicate light signs that are consistent with their conventional usage. Therefore, indications for THMPs are restricted to self-medication and do not require medical intervention. Any labeling, leaflet, and Advertisements for these goods have to include a specific statement: THMP), absolutely based on a long-standing usage, for use in the indicated application". Only Over-the-counter (OTC)usage is permitted for THMPs. Advertisement regarding medical products is prohibited from stating their effectiveness or

safety is primarily attributable to the fact that they are natural substances under Article 90(h) of Directive 2001/83/EC.(31)

Post-market Surveillance
As many herbal products lack complete testing for their effects and risks, pharmacovigilance is crucial for identifying any adverse reactions. HMP must follow EU regulations for continuous monitoring and pharmacovigilance to ensure safety concerns are identified and addressed. However, monitoring the safety of HMPs presents challenges due to their unique characteristics and regulation compared to conventional medicines, requiring adaptation of existing post-market monitoring methods. The primary technique to determine safety signals in connection with herbal medications is spontaneous reporting. Adverse drug reaction reports are collected and analyzed using statistical methods to identify disproportionate reporting rates. The most extensive collection of ADR reports exists at the WHO's Collaborating Centre for Monitor Drug Safety, and EudraVigilance is the technology that is employed in the EU to manage safety information. The data gathered is published in the EU databases of assumed adverse drug response reports. An accepted technique for assessing safety is prescription event monitoring, but it has limited use for herbal medicines due to their infrequent prescription. Case-control and cohort investigations are a few examples of pharmaco epidemiological techniques that are used to evaluate the hypothesis that is being formed after identifying safety signals, although these techniques are not utilized for herbal medications. Lack of Standardization: Herbal medicines are derived from natural sources, and their chemical composition can vary significantly due to factors such as plant species, growing conditions, and preparation methods. This lack of standardization makes it challenging to conduct consistent and reliable pharmacy oepidemiological studies on herbal products.(32) Manufacturers are obligated to submit Periodic Safety Update Reports(PSUR)to appropriate agencies for each authorized medicine as part of their drug surveillance duties. These reports include an assessment of the benefit-risk balance and an update on the product's global safety experience. However, PSURs aren't often required for low-risk or outdated medications, such as THMPs and medications with an extended duration of usage. Rather, PSURs are limited to providing upon request or when the marketing authorization contains a condition.(33)

Introducing Natural/Herbal Medications to the European Market
Organizations must comply with national procedures that are observed by National Competent Agencies to launch herbal/traditional medicinal goods to the EU Member States' market. Three primary regulatory channels may be utilized to sell herbal health goods in EU member countries(21)

Application Requirements
The application for traditional medicine includes:
a. Name and permanent address of the producer(manufacturer).
b. Name of the drug.
c. Information on all of the pharmaceutical product's components, especially qualitatively and quantitatively.
d. Assessment of the possible environmental hazards associated with the medicinal product.
e. Explanation of the production process.
f. Intended therapeutic uses, situations where usage is not recommended, and side effects.
g. Dosage instructions, form of medication, how it's administered, and the estimated lifespan.
h. Justification regarding any necessary safety precautions or storage conditions to storethe product.
i. Explanation of the quality control techniques utilized by the manufacturer.
j. A brief overview of the product's characteristics.
k. Documentation demonstrating that the manufacturer has the authorization to make pharmaceuticals in the country where they operate.(34,35)

Registration Requirements of Herbals in Europe
The EMA includes the HMPC, which provides authoritative assessments based on herbs and remedies, accompanied by instructions on their suggested applications and secure use requirements. This provides a clear reference point for

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enterprises and national competent authorities when drafting an authorization to market or registration proposal for herbal medicines in the EU's member countries being evaluated. The main functions of HMPC include

- The HMPC is responsible for developing EU monographs that outline the acknowledged therapeutic benefits and acceptable dosage levels for natural medicines and preparations of herbal medicine.
- The Herbal Medicines and Healthcare Product Regulatory Administration of the European Union created the Traditional Herbal Medicines Registration Scheme (THMRS), which lists plant-based ingredients, mixtures, and formulations that can be added to traditional herbal medications. To make the process for registering traditional herbal medical items simpler,2001/83/EC amended Directive 2004/24/EC to implement these rules. The primary aim of these guidelines is to safeguard the general population's health while advancing the sale of herbal medications. The active ingredients, herbal substances, herbal preparations, or a mixture of both might be found in traditional herbal medicines. (19)

Simplified Registration Procedure
Directive 2004/24/EC (the Herbal Directive) developed a streamlined registration process in 2004 for traditional herbal medicines that have a long history of medical use (at least 30 years, including 15 in the EU) but do not meet the criteria for "well-established use" required for marketing permission. The streamlined procedure for registration seeks to safeguard the free circulation of herbal medicines across the EU and promote health for everyone.(36,37)

Safety and Quality Standards
Traditional herbal remedies must adhere to the safety and quality criteria as fully licensed pharmaceuticals to get Traditional Herbal Registration (THR).(38)

Scientific Evidence
The EU wants comprehensive scientific evidence to assure the safety and efficacy of all pharmaceuticals, including herbal therapies. There should be documented scientific research on the acknowledged safety and effectiveness of traditional herbal medicines.(36)

Traditional Medicinal Use: For natural medical goods to be registered, proof of at least 15 years of traditional medicines use in the member states of the EU and that all have developed pharmacovigilance programs is required.

Manufacturing and Quality: Requests for conventional herbal medicines must meet the same criteria as those for marketing authorizations. The availability of contemporary science-based public summaries in the European Pharmacopoeia and their counterparts generated by the pharmaceutical sector will influence the efficacy of herbal ingredients as well as medicinal products.(39)

Pharmacovigilance Requirements
Adverse Event Reporting
Marketing Authorization Holders (MAHs) of herbal drugs are obligated to set up procedures for gathering and evaluating data on adverse events (unwanted effects) associated with the drugs they sell. These adverse occurrences might include both known and undiscovered adverse reactions, as well as any additional information linked to safety.

Timely Reporting
Adverse incidents must be informed to the proper organizations within certain timeframes. The intensity of the occurrence determines the timeliness of reporting. Serious adverse reactions, particularly those that result in mortality or a life-threatening scenario, must be reported as soon as possible.(40)

Risk Management Plans (RMPs)
An RMP may be necessary in some circumstances for herbal medications. A Risk Management Plan (RMP) includes methods for determining, characterizing, and managing known and prospective hazards connected with herbal medicine. It contains strategies to reduce those dangers.(41)

Marketing Authorization

The herbal products must have marketing authorization approval before being introduced into the market. Based on the application there are 4 pathways for applying a marketing authorization within the EU described in Figure: 2

Centralised Procedure

For herbal medical goods that are designed to be sold and promoted throughout all EU member states as well as in Iceland, Liechtenstein, and Norway, the Centralized Procedure in theEU is a legal means to receive marketing approval. The European Medicines Agency (EMA) is in charge of coordinating the Centralized Procedure. The applicant makes a single submission to the EMA for herbal products seeking clearance via the Centralized Procedure. The application is assessed by the EMA together with data regarding the effectiveness, security, and purity of the herbal product. The EMA issues a centralized marketing authorization that is valid in all of the nations that participate if the herbal product complies with the essential requirements. (44)

Decentralized Procedure

The Decentralized Procedure for herbal remedies is comparable to that for traditional pharmaceuticals. When a candidate wishes to concurrently sell a herbal remedy in many EU member states, it is employed. The application is evaluated first by the "Reference Member State" (RMS), which is one member state. The other "Concerned Member States" (CMS) receive a draft assessment report that was prepared by the RMS. The CMSs are given the chance to voice any concerns or complaints. The RMS gives a joint marketing authorization, allowing the herbal product to be advertised in all of the contributing member states, if there are no complaints or if any objections are overruled.(45)

Mutual Recognition Procedure

Acquiring marketing permission for herbal goods within the EU can also be done through the Mutual Recognition Procedure (MRP). The MRP enables an applicant to request recognition of that authorization in other member states (the "Concerned Member States" or CMS) if a herbal remedy has already received permission in one EU member state (the "Reference Member State" or RMS).The RMS conducts an initial evaluation after receiving the application from the applicant. After receiving permission from the RMS, the applicant may utilize the MRP to ask the CMSs to recognize the RMS's judgment. If the CMSs concur with the RMS's judgment, they issue the herbal product their national marketing authorizations, allowing it to be promoted in their respective nations.(46)

National Procedure

The simplest method for gaining marketing authorization in each EU member state is the National Procedure for herbal goods. To commercialize their herbal product, the applicant applies directly to the national competent authorities of that nation. The national authority assesses the request by its specific rules and specifications before approving or rejecting marketing licenses for just that particular nation. Herbal goods designed for marketing only inside one EU member state are subject to the National Procedure. It's vital to remember that due to differing international laws and standards, the particular processes and specifications for herbal product certification might change in different nations and areas outside the EU. To guarantee that their products fulfill consumer quality, efficacy, and safety criteria, producers and sponsors of herbal remedies must adhere to every regulation and law that applies.(43,47,48)

Challenges

The Difficulties with Herbal Medicines

One of the main difficulties is to impartially evaluate contradictory information from toxicology, epidemiology, and other sources, as well as ensuring the authenticity of the botanical substances employed.

The following primary concerns still need to be addressed:

- Communicating uncertainties.
- Providing comprehensive documentation of pharmacology, toxicity, and clinical aspects.
- Maintaining pharmacovigilance.
- Investigating the mechanisms behind the efficacy of harmful additives.

- Assessing potential drug interactions.
- Addressing limitations related to available participants and clinical trial constraints.
- Implementing standardization measures.
- Conducting thorough safety and efficacy evaluations. (49)

Issues with the Regulatory Status of Herbal Medicines

A regulatory structure for historic herbal medical goods in the EU was intended by the THMPD, which went into force in 2004. The cumbersome and expensive nature of its execution, however, has drawn criticism from small producers of conventional herbal treatments.(50) Complexity of Registration Procedure: Registering herbal medications may be a lengthy and costly procedure. For traditional herbal treatments that have an extensive record of safe usage but lack comprehensive clinical trial evidence, meeting the demands for safety and effectiveness data might be difficult. Lack of Standardization: Because medicinal products are derived from natural sources, their chemical structure might vary according to factors such as plant species, growth circumstances, and preparation techniques. Because of this lack of uniformity, it is difficult to apply similar regulatory standards across various items. Mutual Recognition Procedure (MRP): The MRP permits herbal medical products authorized in one EU member country to be accepted and acknowledged in other EU member countries. Variations in the interpretation of regulations by various member states, on the other hand, might cause delays and discrepancies in the authorization process.(51)

Challenges in Evaluation of the Safety and Efficacy

It is undoubtedly that the standards, research procedures, benchmarks, and strategies required to assess the safety as well as herbal medications' effectiveness are considerably greater than what is needed for conventional or standard drugs. There may be several hundred natural components in a solo herbal remedy, and there might be much more in a combination of herbal remedies. Herbs can interact with one another in ways that either strengthen or weaken the therapeutic benefits they have on the body. Combining specific herbs might occasionally have undesirable side effects or lessen the efficiency of the treatment. Analyzing a single essential element in these kinds of situations may be problematic, particularly if the herbal product is a blend of two or more plants.(52)

CONCLUSION

Herbal products play a significant role in human life which are derived from natural sources. The legal framework and utilization of herbal drug products differ greatly from country to country, resulting in challenges for their unrestricted distribution. However, Rules and regulations applicable to medications made from herbs in Europe are among the most thorough and comprehensive worldwide. There are currently five primary regulatory pathways available for manufacturers to market herbal medications or herbal medicinal productsin Europe. To ensure their quality, safety, and effectiveness, herbal healthcare products are subject to regulations within the European Union's rules and regulations for pharmaceuticals. Due to the distinctive characteristics of these products, a simplified procedure has been developed to ensure pharmaceutical quality while still meeting the effectiveness and safety standards needed for marketing support. TheHMPC was created to comply with Directive (EC) No 726/2004 and2004/24/EC. This committee is in charge of the streamlined registration process used by European Union member states for traditional herbal medicine items. Overall, the regulations governing herbal goods in Europe act as an example for other domains, showing how a unified regulatory structure may strike a compromise between protecting the public's health and maintaining cultural assets. These rules will keep evolving as knowledge develops and new research is published, ensuring that herbal remedies continue to be a crucial and secure component of healthcare in the EU.

Abbreviations

ADR- Adverse Drug Reaction
CAM- Complementary and Alternative Medicine

CMS- Concerned Member States
EDQM- European Directorate for the Quality of Medicines & HealthCare
EMEA/EMA- European Medicines Agency
EU- European Union
HM- Herbal Medicine
HMPC- Committee for Herbal Medicinal Product
MHA- Marketing Authorization Holder
MRP- Mutual Recognition Procedure
OTC- Over The Counter
PSUR- Periodic Safety Update Reports
RMP- Risk Management Plan
RMS- Reference Member State
THMPD- Traditional Herbal Medicinal Products Directive
THMRS- Traditional Herbal Medicines Registration Scheme
TM- Traditional Medicine
TUR- Traditional Use Registration
WHO- World Health Organization

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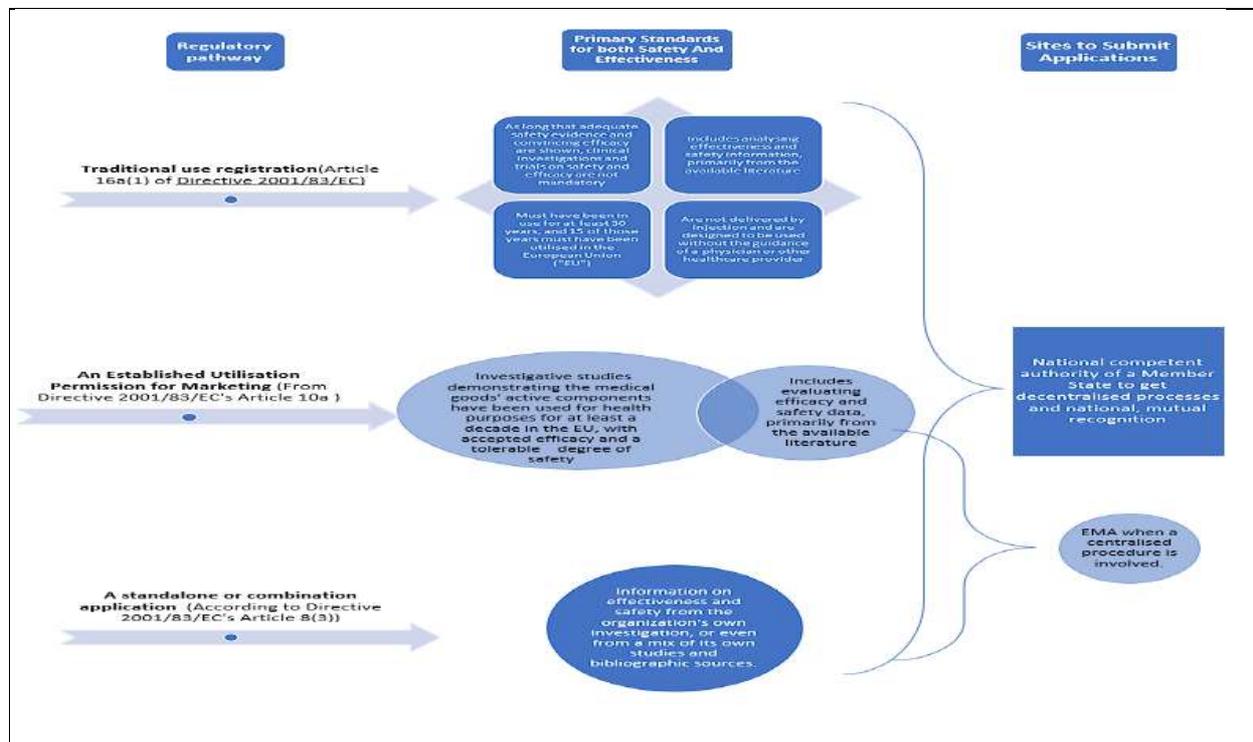
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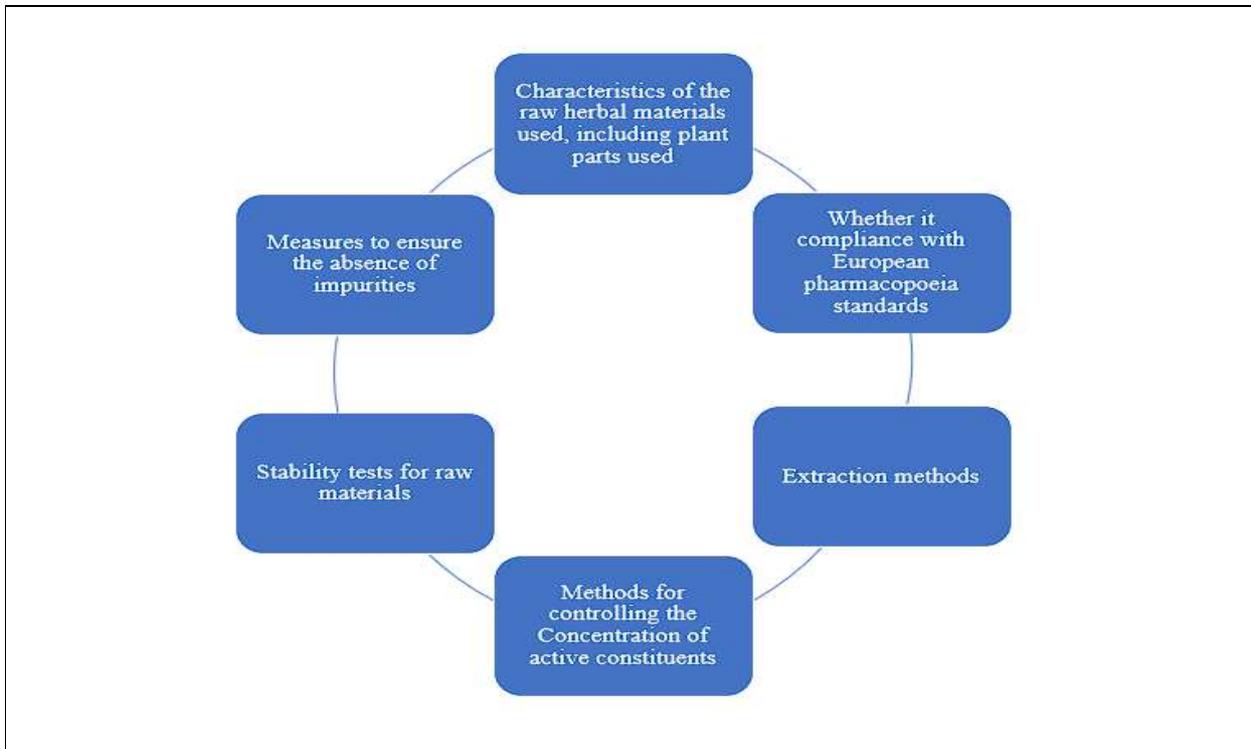
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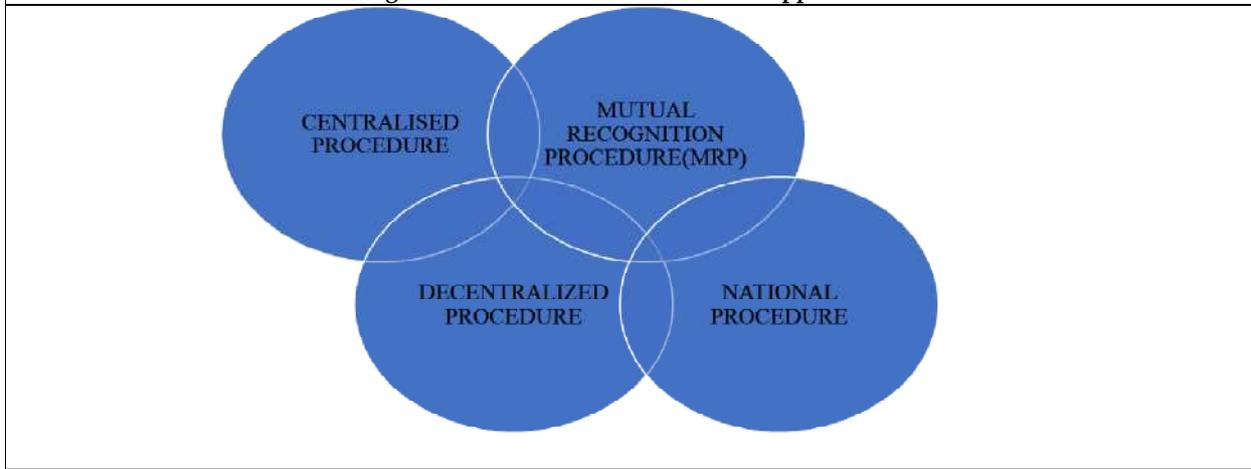
Figure 2: Marketing Authorization Procedures(42,43)

RESEARCH ARTICLE

A Moderation Analysis of Gratitude, Forgiveness and School Well-Being of Secondary School Students

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ABSTRACT

Positive psychologists substantiate that cultivating the pro-social behavior of school students is a major weapon to develop a sustainable society. As pro-social behavior, gratitude, and forgiveness are most comprehensive components to be lived a meaningful life. Although, it can happen only if school environment provides an opportunity to students to perceive school well-being. Research revealed that gratitude, forgiveness, and school well-being are the major components that help to develop school students holistically. So, the present study is aimed to study the moderational analysis of gratitude, forgiveness, and school well-being of secondary school students. Descriptive correlational method was used in the present study and data were collected from 988 school students (class ix & x) of 50 secondary schools by administrating Gratitude questionnaire, forgiveness inventory, and school well-being scale. The present study revealed significant (0.01) correlation between gratitude and school well-being, and forgiveness and school well-being. However, the correlation between forgiveness and gratitude is found not significant. The study also revealed no moderation effect of the interaction of forgiveness and school well-being on gratitude, the interaction of gratitude and school well-being on forgiveness, and the interaction of gratitude and forgiveness on school well-being.

Keywords: Gratitude, Forgiveness, School well-being.

INTRODUCTION

Gratitude is the appreciation experienced by persons when someone does something kindness or helpful for them [1]. The term gratitude is derived from the Latin word 'Gratia' which entails some alternative of grace, gratefulness

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and graciousness [2]. It is a meaningful and valuable appreciation to someone or a group for their invaluable support and helps [3]. Pruyser mentioned gratitude as "kindness, generousness, gift, the beauty of giving and receiving" [4]. Robert Emmons, a leading positive psychologist defined the gratitude very comprehensively as "a sense of thankfulness and joy in response to receiving a gift, whether the gift be a tangible benefit from a specific other or a moment of peaceful bliss evoked by natural beauty" [5]. He further conceptualized the gratitude as an emotion, a virtue, a motive, a skill and an attitude, a moral sentiment, and a coping response [6]. McCullough and colleagues defined the gratitude in the sense of moral barometer, moral reinforcer, and moral motives.[2] As a moral barometer, gratitude serves for beneficiaries by signaling the value of relationship with supporter for the gift offered upon them; as a moral reinforcer gratitude increase individual's positive hope and expectation about their future; and as a moral motive gratitude increase the offering pro-social behavior towards other people. So, they believed that grateful people always accept everything as a gift and applied this positive viewpoint in a relational context. Hussong and colleagues also defined gratitude as a "cognitively-mediated, socio-emotional process that results in a sense of appreciation, happiness or joy due to the appraisal of having received something, which is not due to personal effort but to a benefactor's free and unrestricted intentions to give" [7].

It has been seen much argued regarding the meaning of forgiveness [8]. Although, majority of existing literature regarded as human strength [9], as interpersonal process [10], as self focus process [11], as forgiveness of self, others, and situation [9]. To define the forgiveness, Hargrave and Sells focused on 'dyadic forgiveness' and conceptualized the forgiveness an overt expression and careful reconciliation [12]. McCullough and colleagues asserted forgiveness in the sense of reflects increase in pro-social motivation towards another such as- the less desire to avoid the transgressing person and to harm or seek revenge toward that individual and increase desire to act positively toward the transgressing person [13]. Enright and colleagues defined forgiveness as "a willingness to abandon one's right to resentment, negative judgment, and indifferent behavior toward one who unjustly hurt us, while fostering the undeserved qualities of compassion, generosity, and even love toward him or her" [10]. The positive psychologists defined forgiveness as freeing from a negative attachment to the source that has transgressed against a person [9], in the sense of reflects increase in pro-social motivation towards another such as- the less desire to avoid the transgressing person and to harm or seek revenge toward that individual and increase desire to act positively toward the transgressing person [13], and as "a willingness to abandon one's right to resentment, negative judgment, and indifferent behavior toward one who unjustly hurt us, while fostering the undeserved qualities of compassion, generosity and even love toward him or her" [10]. Baumeister and colleagues mentioned two dimension of forgiveness in their forgiveness model viz. intra-psychic and interpersonal [14]. The intra-psychic forgiveness refers to whether an individual has forgiven whereas the interpersonal forgiveness describes whether an individual has communicated forgiveness to their transgressor. Hillman hypothesized the components of Brecker's tripartite framework of human attitude with two dimensional model of forgiveness and identified three types of forgiveness viz. behavioral (external) forgiveness, affective (internal) forgiveness and cognitive (internal) forgiveness [15].

School well-being is the positive experiences of a student perceived in a school environment. Tian and colleagues stated school well-being as a student's school satisfaction and positive effect on school. According to them, school satisfaction refers to a global cognitive evaluation of school life that emerge from day to day school experience of students and positive affect in school refers to the frequency of positive emotions experienced especially during school such as feelings relax, pleasant, hope, safe or more importantly happiness and satisfaction of the students [16]. It is a concern with positive effect, persistence, strength, dedication, and concentration of school activities and is strongly correlated to the feeling of self-efficiency and students' motivation towards positive hopes and feelings. School well-being can be perceived through the achievement of meaningful goals, relationships, personal growth and development, health, safety, and satisfaction. Konu and Rimpela mentioned that school well-being is more important to develop positive emotions like hope, resiliency, joy, optimism, and health of students to improve their well-being [17]. Seligman, the conceptual founder of positive psychology also argued the importance of school well-being and mentioned its reasons such as (i) the current flood of depression (ii) the nominal increase in happiness over the last two generations (iii) well-being enhances learning and holistic thinking (iv) an antidote to the runway incidence of depressions (v) a way to increase life satisfaction and (vi) an aid to better learning and more creative

thinking [18]. Regarding the above-mentioned core reasons, researchers and psychologists in the field of positive psychology started to argue for the framework of schools for the well-being of students [19, 20, 18]. And these ideas are the resource to develop a new area of positive psychology named 'school well-being. Health Education Partnership Limited, Norwich suggested three basic areas of school well-being such as- emotional well-being, psychological well-being, and social well-being school students [21].

The related literatures showed that most of the studies in gratitude had been conducted on adults. Despite of it only inconceivable studies have been conducted on child/adolescents. So, majority of research tools and techniques constructed of gratitude are focused on only adults. Froh and colleagues mentioned that the gap of the study on gratitude between adults and child/adolescents is the question of understanding and developmental implications of gratitude and most of the researchers are regarded it as inevitable points [22]. But some study revealed that gratitude emerges from earliest stages of infancy [23], between 7-10 ages [24], between 6-10 ages [25], and fully matured at age10 [26]. So, emerging studies of gratitude on children and adolescents are extended and designed for measuring both emerging gratitude and mature forms of trait gratitude [1]. Many psychologists argued that the study of gratitude of adolescent is more important for several reasons. First, it associated with positive emotional functioning [1] and linked positive affect [27, 22]. As a positive emotion gratitude proceeds toward better life outcomes [28], healthier life and more resilient, optimism and well-being [29], broaden the analytical strategies [30], and more importantly gratitude reduce the negative emotions [31]. Second, gratitude is associated to a wide range of pro-social social outcomes viz. compassion, healthy relationships, generosity and empathy [2], and develop the optimism and positive affect among middle school students [22]. Third, gratitude increase social functioning of adolescents that indentified as a major component of pro-social behavior [27]. Researchers found several studies conducted to measure the relation of gratitude with others variables. The studies revealed that the gratitude among early adolescents is negatively associated with physical symptoms whereas it is positively associated with school satisfaction, positive effect, social support, optimism, and emotional support [22], among late adolescents gratitude is positively associated to academic achievement, social integration and negatively associated with envy and materialism [1], gratitude enrich more positive emotions of school children [25], and gratitude has positive relationship between optimism, and well-being in adolescent [29].

As similar to the gratitude, review of related literatures revealed that most of the study in forgiveness had been conducted on adult. Leever mentioned two reasons for the gap of the study on forgiveness between adults and adolescents. First is the question of understanding and developmental implications of forgiveness and second is whether adolescents exhibit similar forgiveness trends as adults. Although, understanding of the concept of forgiveness of children and adolescents under different conditions has been previously studied and it revealed that the development of the concept of forgiveness is normally occurring at a young age [32]. Darby and Schlenker conducted a study to evaluate the children's understanding of forgiveness and adult in social judgments (i.e. intentions, apologies, and motives) and revealed similar result with adults [33]. Park and Enright also conducted a study to measure the developmental progression of the understanding of forgiveness of adolescents in Korea and revealed that external as well as internal forgiveness exists among adolescents [34]. Thompson and Snyder also revealed that motivation for forgiveness of child and adults is occur in the same manner and it is linked to psychological health and well-being [35] while un-forgiveness is correlated with higher psychopathology [36, 37]. Furthermore, the different abnormality of individual related pathologies depends on the amount or type of forgiveness [38]. Personality factors have been found to highly correlate with dispositional forgiveness of both self and others [39]. Failure to forgive self has been connected to more intra-punitive pathologies such as- anxiety and depression, while failure to forgive others has been associated with extra-punitive pathologies, such as- social alienation, social introversion, depression, and psychoticism [40]. Mauger and his colleages also found deficits in forgiveness of self related to higher amounts of overt psychopathologies e.g. schizophrenia [41].

The study of the school well-being is relatively new concept of positive psychology. Konu and Rimpela is the pioneer of the study of school well-being [17]. They developed the 'school well-being model' based on the sociological perspective of the 'well-being model' [42]. After development of the school well-being model, researchers of positive

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psychology started to study on school well-being of school students especially in Finland. The basic idea of the school well-being model is to assess well-being as an entity in a school setting. In present decade, the term school well-being is popularly used as an explicit educational aim [43]. Many developed countries have been preparing their school as a responsible institution to contribute to well-being of students, society, usually in the form of well educated and healthy workforce. Finland, New Zealand, Australia, England, United State of America and more recently China, Indonesia and Japan in Asia are some countries which explicitly stated the well-being of the students in the national curriculum. The Ministry of Education of New Zealand stated 'school well-being is vision for young students who will seize the opportunities offered by new knowledge and technologies to secure a sustainable social, cultural, economic and environmental future for country. Many researchers have conducted study on well-being and academic perspective of students and revealed that emotional well-being is a most powerful indicator of academic achievement and success of students and subsequently it improves the quality of later life (youngminds.org. uk). Gutman and Vorhaus found that students with higher level school well-being perceived higher levels of academic achievement and interestingly they are more engaged in school activities.[44] Duckworth and Seligman studied well-being and intelligent as a determinant of student's academic achievement. They found that emotional and social well-being of students is more significant determinant of academic achievement than Intelligent Quaint [45]. An international study of OECD also revealed a positive correlation between social and emotional well-being of school students. According to Durlak and colleagues, the ability of the emotional management of students can support their learning, commitment, academic engagement, and ultimate school success [46]. The study of Buecker and his colleagues revealed that subjective well-being of students is the powerful approach to solve the disciplinary problems of school students, to improve school satisfaction, enhance academic achievement and flourishing of students, communities as well as nations [47]. The positives emotions of the students which assembled by school well-being enlarges cognitive perspective, level of creativity, productivity and leads the gratitude, hope and emotional regulation of students and offering a happy life [48]. Literatures revealed that school well-being is more important in developing student's competency, resilience, and health in order to improve their well-being [49, 50, 51]. World Health Organization (WHO) mentioned that the national growth and development is highly dependent on health status, quality of the students and well established school environment [52]. Mental and emotional well-being of students improves their performance and broadens the intellectual, physical and social resources of a nation [18]. Students with better emotional and mental health are easier to relate with work, better decision makers, are more creative and better in problem solving, innovation, persistence and productivity [53, 18].

After precisely reviewed the related literatures of gratitude, forgiveness, and school well-being of secondary school students, researchers did not able to find literatures that conducted to study on the relationship between the variables under study. Therefore, this study is an effort to minimize the literatures gap.

Research Objectives
1. To analysis the descriptive statistics of gratitude, forgiveness, and school well-being.
2. To establish the bivariate correlation between gratitude, forgiveness, and school well-being.
3. To perform the moderation analysis of gratitude, forgiveness, and school well-being.

METHODOLOGY AND MATERIALS

Descriptive survey method was used in the present study. The sample students were selected by applying a stratified random sampling technique. Accordingly, 988 school students (ix & x) of Tinsukia district, Assam were selected as a sample and collected the required data. The sample students are comprised of different examination boards i.e. Board of Secondary Education, Assam (SEBA), Central Board of Secondary Education (CBSE), and Indian Certificate of Secondary Education (ICSE). Three measuring scale were used in the present study. Brief descriptions of the scales are given below.

- **Gratitude Questionnaire-6 (GQ-6)** GQ-6 is consists of six items usually used to measure the gratitude of adults only but revalidated it by factor analysis to measure the gratitude of adolescents.[1] The revalidated version is

consisted of five items and it is used in the present study. The item 6 of the original GQ-6 was eliminated for its high difficulty index for adolescents. GQ-6 is a 7 point Likert type scale, so scoring procedure of favorable and unfavorable statements suggested by Likert is applied. Higher scores in the scale indicate higher level of gratitude and lower scores in the scale indicate lower level of gratitude.

- **Child/Adolescent Dispositional Forgiveness Inventory (CADFI)** The Child/Adolescent Dispositional Forgiveness Inventory [34] is modified version of Heartland Forgiveness Scale.[9] It was modified to measure the forgiveness of children and adolescents. The scale is comprised of 3 subscales viz. Forgiveness of Self (5 items), Forgiveness of Others (3 items) and Forgiveness of Situation (6 items). The scale is a 7-points scale ranging from 1 (almost always false of me) to 7 (almost always true of me). Higher scores in the CADFI indicate higher level of forgiveness and lower scores indicate lower level of forgiveness.
- **School Well-Being Scale** The school well-being scale constructed and standardized by Mili & Buraguhain [54] is used in the present study. It is a 60-item scale constructed and standardized to measure the level of school well-being of secondary school students. The school well-being scale is a five-point Likert-type scale. The scoring procedure suggested by Likert for favorable and unfavorable items was followed. The total of all the responses score constituted the total school well-being score of the students. A higher student's score on the scale referred to higher school well-being and a lower student's score on the scale referred to lower school well-being of the students.
- **Statistical Analysis** Statistical analyses were conducted with the Statistical Package for the Social Sciences (SPSS) version 26. The statistical techniques i.e. Mean, Standard deviation, bivariate correlation analyses, and moderation analysis were applied and interpreted.

RESULTS AND DISCUSSION

The researchers decided to analysis and interpret the obtain data as per as the sequence of the objectives and the findings of the present study are presented below with the help of appropriate tables and models along with their interpretation accordingly.

Objective-1: To analysis the descriptive statistics of gratitude, forgiveness, and school well-being of secondary school students. In this regards, descriptive statistics were calculated and which shown in **table- 1.**

Table 1 presents the descriptive statistics. The mean and standard deviation of school well-being, forgiveness, and gratitude were found 232.15, 28968; 60.38, 7.852; and 26.42, 5.151 respectively. The researchers further attempted know the descriptive levels of variables under study in category wise viz. male, female, rural, and urban. Details were given in table 1.

Objective- 2: To establish the bivariate correlation between gratitude, forgiveness, and school well-being.

Table 2 shows the Pearson's coefficient of correlation of gratitude, forgiveness, school well-being of secondary school students. The correlation between gratitude and school well-being, and forgiveness and school well-being were found significant at 0.01. However, the correlation between forgiveness and gratitude is found not significant. Further, the researchers attempted to know the correlations of gratitude, forgiveness, and school well-being in category wise viz. male, female, rural, and urban. Correlations were found significant at 0.01 level of significance. Details are given in the **table 3.**

Objective- 3: To perform the moderation analysis of the variables under study. So, researchers tried to investigate the moderation effect of each other of the variables. In this regard, researchers carried the moderation process by a conceptual model given below (conceptual model 1).

Statistical model 1 presents the process of moderation analysis. Before test the moderation effect of school well-being and forgiveness as an independent variable, researcher checked whether there were significant correlation between gratitude with school well-being and as well as forgiveness. The result showed a significant correlation (p < 0.05) between gratitude and both the independent variables (school well-being & forgiveness). Then, researchers proceeded to test the moderation effect. So, researchers created a new moderating variable (interaction) run the statistical model. The result showed a no significant moderation effect on gratitude of secondary school students, because the p value is found greater than the 0.05.

Again, **statistical model 2** presents the process of moderation analysis. Before test the moderation effect of school well-being and gratitude as an independent variable, researchers checked whether there were significant correlation between forgiveness with school well-being and gratitude. It was found a significant correlation ($p < 0.05$) between forgiveness and both the independent variables (school well-being & gratitude). Then, researchers created a new moderating variable (interaction) and tested its effect on forgiveness. However, the result showed a no significant moderation effect ($p > 0.05$) on forgiveness of secondary school students.

Statistical model 3 presents the moderation analysis. To carry out the moderation analysis, researcher checked whether there were significant correlation between school well-being with forgiveness and gratitude. And, the result showed a significant correlation ($p < 0.05$) between school well-being with both the independent variables (forgiveness & gratitude). Then, researcher proceeded to test the moderation effect. So, researchers created a new moderating variable (interaction) and tested its effect on school well-being. However, it was found a no significant moderation effect ($p > 0.05$) on school well-being of secondary school students.

CONCLUSION

In the present study, researchers attempted to study the co-relationship between gratitude, forgiveness, and school well-being of secondary school students. In this regards, researchers found significant (0.01) correlation between gratitude and school well-being, and forgiveness and school well-being. However, the correlation between forgiveness and gratitude is found not significant. Further, the researchers estimated the correlations of gratitude, forgiveness, and school well-being in category wise viz. male, female, rural, and urban. And, correlations were found significant at 0.01 level of significance. In the moderation analysis, researchers found that interaction of forgiveness and school well-being has no moderation effect on the relationship between school well-being and gratitude. Similarly, it was found no moderation effect of the interaction of gratitude and school well-being on the relationship between school well-being and forgiveness. Again, no moderation effect of the interaction of gratitude and forgiveness was found on the relationship between gratitude and school well-being.

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Table 1: Descriptive statistics

Category	Mean	SD
School well-being (as a whole)	232.15	28.968
Forgiveness (as a whole)	60.38	7.852
Gratitude (as a whole)	26.42	5.151
School well-being of Male students	226.47	29.125
School well-being of Female students	237.31	27.982
School well-being of Rural students	232.40	28.90
School well-being of Urban students	231.61	29.14
Forgiveness of Male student	60.63	7.902
Forgiveness of Female students	60.16	7.809
Forgiveness of Rural students	60.42	7.786
Forgiveness of Urban students	60.28	8.016
Gratitude of Male student	26.17	5.081
Gratitude of Female students	26.64	5.207
Gratitude of Rural students	26.53	5.100
Gratitude of Urban students	26.18	5.268

Table 2: Correlation of the variables under study

Variables	Coefficient of correlation
School well-being & Forgiveness	.210**
School well-being & Gratitude	.163**
Forgiveness & Gratitude	.015

Table 3: Category wise correlation of the variables under study

Variables	Coefficient of correlation
SWB (M) & Forgiveness (M)	.210**
SWB (F) and Forgiveness (F)	.228**
SWB (R) and Forgiveness (R)	.209**
SWB (U) and Forgiveness (U)	.212**
SWB (M) & Gratitude (M)	.129**
SWB (F) & Gratitude (F)	.184**
SWB (R) & Gratitude (R)	.163**
SWB (U) & Gratitude (U)	.163**

(Noted: SWB = School well-being, M = Male, F =Female, R = Rural, U =Urban, and ** = significant)
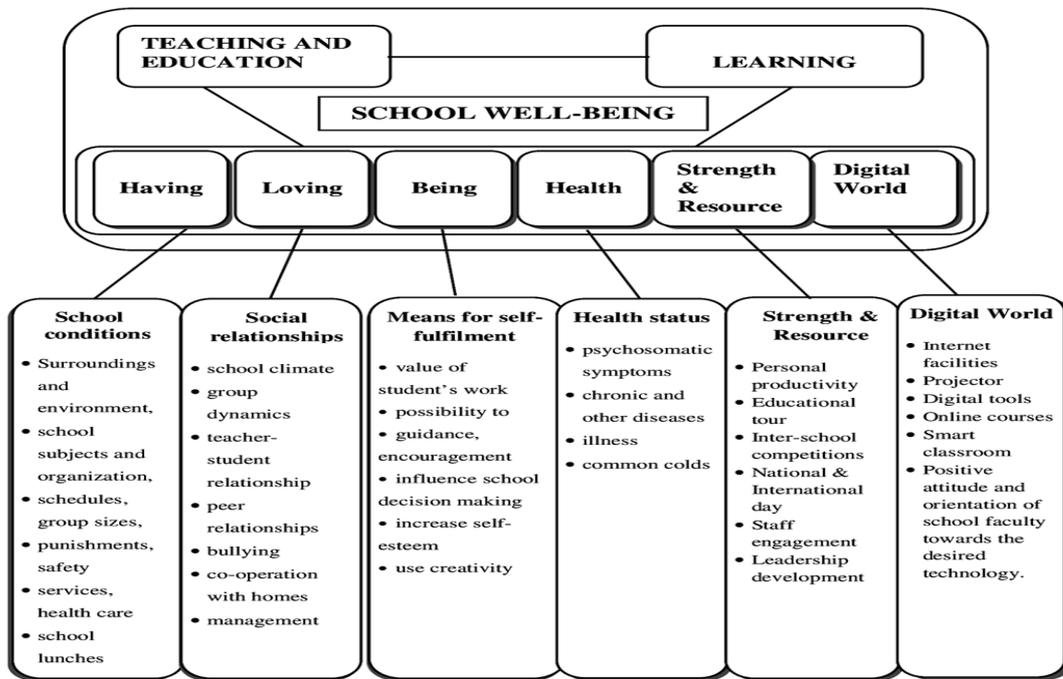
Source: Factor structure of the school well-being model (19)

Figure 1: School well-being model [19].
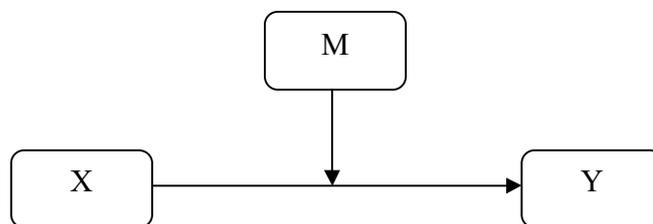
Statistical Model 1
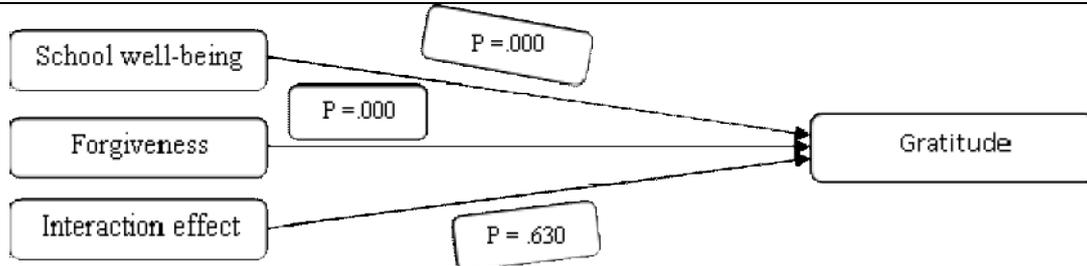
Statistical Model 1

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Statistical Model 2

Statistical Model 3

RESEARCH ARTICLE
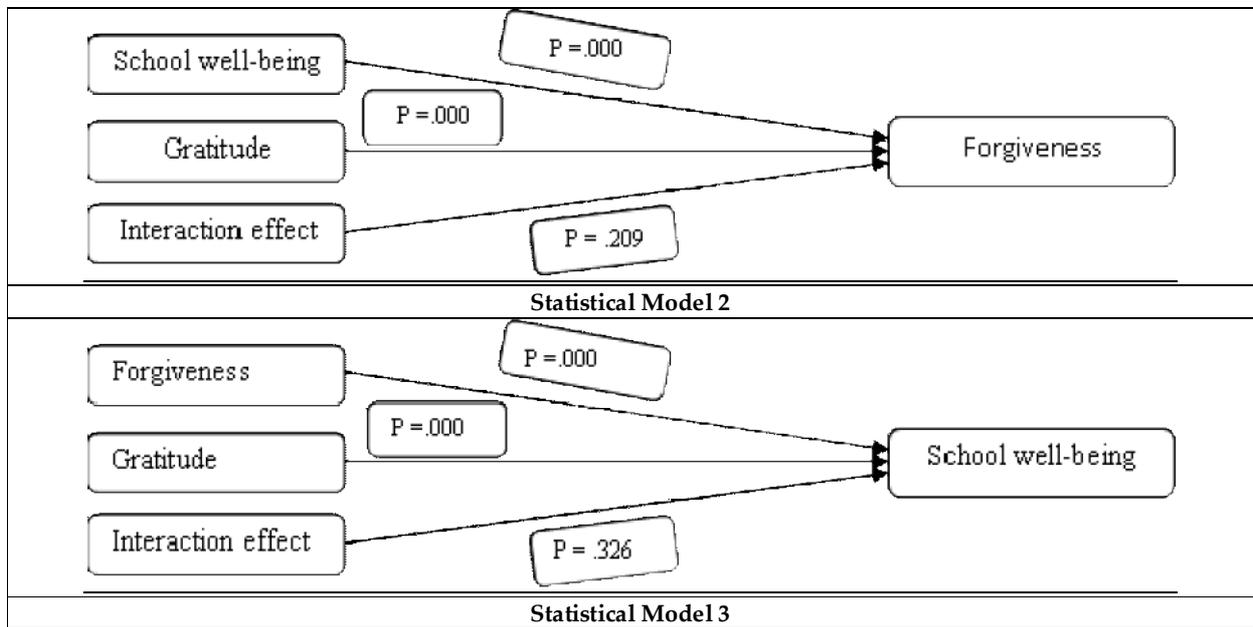
Unveiling the Day-to-Day Challenges of People with Dwarfism - a Qualitative Inquiry

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ABSTRACT

Despite the fact that society has become tolerant and inclusive, people with dwarfism still experience discrimination in every aspect of life. This is because the society had perceived them as a mere difference of having shorter body size than being disabled. Such perceptions eventually kept them out of the societal purview. Hence this study is intended to uncover their distinct challenges which extend from personal to public spaces. For this the researcher employed purposive sampling technique to collect data from 12 participants using semi structured interview guide. The inclusion criterion is that the participants must be a member in Tamil Nadu Dwarfism Welfare Association, with the notion of providing rich and in-depth information on the research objectives. Thematic analysis was done to analyse and interpret the data. The findings had three broad themes such as challenges at personal spaces, challenges at public spaces and psycho-social challenges explained under nine different sub themes. The results are interpreted using socio ecological model with the individual at the centre, surrounded by family, welfare organization and policy making bodies at different levels. The challenges encountered by people with dwarfism can be eliminated by the combined efforts of the individual, family, welfare organization and policy making bodies to attain a living with utmost wellness.

Keywords: People with dwarfism, Disability, Day-to-day challenges, Qualitative, Thematic analysis.

INTRODUCTION

Dwarfism is a medical or genetic condition that results in short stature, characterized by an adult height of about 147 centimetres or less, of both proportionate and disproportionate body sizes (Little People of America, 2020). In India, the Rights of Persons with Disabilities Act (RPwD) of 2016 had increased the types of disabilities from 7 to 21, of which the category of dwarfism is included as one form of physical disability (Narayan et.al., 2017). However, dwarfism is socially perceived as a mere difference of having shorter body size and hence fail to consider them as disabled (Shakespeare et.al., 2010). It is observed that the body size of people with dwarfism, is incapacitating in a built environment created for an average sized person, but that a body size that differs greatly from the average is not accepted as disability in society (Pritchard, 2021). Additionally, their medical conditions are not apparent always and the general insight that most people with dwarfism do not have severe physical restrictions on their activities had also amplified the negligent attitude of the society (Thompson et.al, 2008). Within the context of disability discourse, dwarfism borders on dual concepts of stigma and identity. People with dwarfism are affixed with an in-born ascribed stigma, through which they are branded as different and consequently devalued that seldom transpose (Olaniyan 2019). In terms of identity, they are regarded as "discursive identity" and are centered around the butt of humour and curiosity (Kruse 2003).Having said that, like any other forms of physical disabilities; People with dwarfism also experience difficulties on a daily basis owing to their body size and inability to fit into the socially constructed norm. The phase of literature review disclosed that most of the studies concerning people with dwarfism focused only on the issues of stereotyping, their cultural representation and media portrayal. It is acknowledged that the society's ignorance towards their disproportionate body sizes is the reason for the concealment on the difficulties they experience. Therefore, the study is intended to comprehend the distinct challenges faced by people with dwarfism on everyday basis. In the present study, the intricacy encompassing disability issues informed the use of Bronfenbrenner Socio ecological model (1976) as the theoretical framework. According to him, people are trapped in a nested system in which many components have a substantial impact on how they grow, and such developments are primarily affected by the interactions between people and their environment (Akotoet.al, 2022). As this study demands to understand the challenges of people with dwarfism, they are placed at the center, surrounded by the family support at the level of micro system, and the role of welfare organization at the level of meso system and the policy making bodies at the level of macro system. (See Fig. 1)

MATERIALS AND METHODS

Participants
Purposive sampling technique was used to select 12 individuals with dwarfism, between the age group of 20-40 years of which 6 are male and 6 are female. The inclusion criterion is that the participants must be a member in Tamil Nadu Dwarfism Welfare Association with the notion of providing rich and in-depth information on the research questions. As the study involved people of marginalized section, pseudonyms were used instead of the names of the participants. Table 1 illustrates the demographics of the participants.

Data collection
Face to face interviews were carried out for about 45-60 mins to gather information on the research objectives through semi-structured interview guide. In the interview, the participants were encouraged to share their experience about challenges related to daily life. For instance, what are the difficulties you encounter when you're at home? In what ways the infrastructure in public places hinder your social participation? etc., was followed by probing questions. The participants were aware of the aims and method of the study and written informed consent forms were obtained from all participants. They were given the freedom to leave the study at any time and had their data confidentiality guaranteed.

Data Analysis

All the audio taped interviews were transcribed verbatim and further translated into English without altering the meaning of the conversation. The transcribed data was analyzed manually using thematic analysis (Braun et.al, 2006), where the researcher read the transcripts multiple times to familiarize with the data and started generating initial codes. The codebook had labels or tags assigned to the segments of the data that captured meaningful concepts or ideas. After the completion of initial coding, an overarching category was derived by clubbing similar meaningful codes, followed by systematically grouping the categories to form themes.

Ethical considerations

Bharathiar University Human Ethics Committee approved this study (BUHEC/067/2023). Permission was received from the research supervisor and doctoral committee members of the researcher.

RESULTS

Day-to-day challenges

Participants involved in the in-depth interview spoke about different forms of challenges encountered on daily basis and the emergent themes are as follows: (See Table 2)

Theme I- Underpinning challenges at private life

By virtue of being short, people with dwarfism struggle to execute their daily activities at their private spaces. The implementation of such challenges involves accessing the switch boards, door handles, clothesline, dish washing sink, etc., making it tedious to complete their basic household tasks. In general, the houses of people with dwarfism are not designed to their heights and they seek the instrumental support like scales, sticks, chairs, ladder and tables to access the household equipment's."… I can't get onto the cot without assistance, so beneath my cot there exist a permanent stool for me to climb onto it. Similarly, there will be a long stick against the wall, with which I will on the electric switches..." (P5: 38-year-old employed man)However, the nuclear family composed of both the partners being short statured, design their house in accordance to their height and convenience making life comparatively easier at home."…Since both of us are short, we always had to depend on our family members for the smallest of things. Hence, we restructured our house to our comfort like lowering the kitchen countertops and clothesline to our feasibility…" (P6: 39-year-old married man)

Cooking nonetheless remains an unavoidable challenge in the everyday life of persons with dwarfism. They experience inconvenience while cooking, as the kitchen utensils are considered to be bigger in size and does not suffice the size of their fists. The usage of smaller utensils alone will not be adequate rather certain modifications like lowering the countertops, constructing stable platforms and creating adjustable pull-out shelves in the kitchen must be made in order to accommodate them."... Since the palm of my hands are too small as a child, I have trouble in holding big vessels for the purpose of cooking and to wash dishes. And also, I refrain from hosting visitors for lunch/dinner because I am unable to prepare for large group of people…" (P9: 34-year-old women)To wear clothes of one's own choice and likeness is a form self-expression, unfortunately people with dwarfism are unable to wear clothes of their adoration rather wear those unwilling clothes only for the mere fact of fitting their body size. As a result, people with dwarfism are obliged to use only custom-made dresses to fit their height and size, and this issue of clothing might look very insignificant to average sized people but the real agony is felt when such desires remain unfulfilled."...I wish to wear saree (traditional Indian dress) but I can't as it is very lengthy. Whenever I see women wearing a saree, I feel so jealous of them and eventually will end up thinking as to why God created me this way..." (P10: 26-year-old women)

Theme II- Challenges at public spaces

The infrastructural challenges at public places are immeasurable to a person with short stature. Participants asserted that even to walk on a road without the assistance of a fellow being is arduous, since the operator of huge vehicles at times fail to notice a person of short height and may strike them. Additionally, the placement of service counters, ATMs and restrooms are at an elevation that is beyond their height and combination of all such undisclosed difficulties minimize their involvement in activities outside home."…. I can never use the public toilets as they are built for an average sized man and most of the times, I avoid visiting malls often and I wonder why people are ignorant of our infrastructural needs…." (P1: 32-year-old man)Places of entertainments such as shopping malls, theatres, parks, beaches, hotels etc. are built with facilities that are unapproachable to people with dwarfism. It is because the structural amenities in the entertainment places are established in a manner that are inaccessible to them. With relation to places of worship, on routine days the struggle is minimal when compared to those of a festive season. The temple becomes so crowded that even after trying hard, people with dwarfism can never reach out to the idol statue as they get caught in the crowd. The fear of experiencing breathing difficulties after being entrapped in the crowd serve as a barrier to visit religious places often."…. The seats in the cinema theatres are unfavorable to me and when I sit down to watch a movie, I can only view the head of the person in front of me. I will always feel that some effective modifications must be made to accommodate myself into the theatres …." (P3: 29-year-old-man)

Commutation nevertheless remains a challenge, as the public vehicles are designed without taking their travel needs into consideration. The public transport systems such as trains, buses and auto rickshaws often lack proper accessibility features with high step heights, inaccessible handrails and grab bars, and cramped seating arrangements. Getting onto a public transport vehicle, to accomplish their tasks on an everyday basis is undeniably a strenuous job for them. Apart from this, they will have to strive really hard to get a driving license, therefore the chances of owning and driving a private vehicle of their own is also limited."…. I work for an MNC, and getting to the office every day is not at all a simple chore for me. I'll have to wait for a less crowded compartment for hours in the station because if I get into one, the knees of my fellow passengers would be level with my nose, making breathing difficult. ….." (P7: 27-year-old women)To seek a job is extremely challenging for a person with dwarfism, and if employed; the trouble multiplies due to the inaccessibility of amenities at workplace. It is designed in an unfavorable manner, such that buttons in the elevators, the seating arrangements like chairs and tables and the documents placed, are all at an unreachable height. This is because the workplace is usually constructed for an average sized man and undermined the idea of encompassing people of all sizes comfortably."… At first, when I approached a grocery store for a job, they rejected me for my height and looks. That is when I decided to seek a job where my height and identity will remain invisible to public domain, and eventually ended up in a Business Process Outsourcing company. I experienced difficulty even there as the table and chair were not of my height and will always need a colleague's assistance to get onto it…."(P12: 34-year-old unmarried women)

Theme III- Psycho-social challenges

Constant gazing at individuals with dwarfism, is invasive and offensive which reinforces the idea that they are abnormal and different from others. Such repeated act of gazing manifests that general public is curious to know more about them especially their age and marital status. Respondents stated that when people around stare, it magnifies their fear of being negatively evaluated. This eventually hinders their effective involvement and participation in social situations."………Once my aesthetic average sized girlfriend and I walked on road and I challenged her that people's attention will be on me than the beautiful you. To her surprise people crossing us gazed at me, just because I'm a dwarf and they were curious to know about me, especially my age. This act of staring at me happens very often that makes me feel so uncomfortable…" (P6: 39-year-old man)Respondents asserted that they frequently come across unsolicited comments, mostly derogatory statements about their height, size and other physical features on a daily basis. To call upon them, people often use humiliating names especially those phrases from visual media. They are treated as objects of fun and trolled for not fitting into the socially imposed beauty standards. The intensity of shaming hikes when others in the society gossip about their marital and sexual life in a

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mysterious way. They endure one or more of the aforementioned forms of teasing that consequently lowers their self-esteem and confidence."….. Whenever I join my friends; to play street cricket, they never allow me to take batsman or bowler role, instead my peer mates make fun that I fit only to field along with the small children on the streets. When they treat me as a child, I get hurt…" (26-year-old man)People with dwarfism are always viewed through the stereotypical lens and labels such as clown, joker, entertainer are often used on them. The societal prejudices on the other hand, considers them as 'being pity, childlike, innocent and quick tempered'; eventually ends up in limiting their opportunities. In addition, the preconceived notion that people with dwarfism are incapable to complete a task also exist predominantly. Such unauthentic notions have an adverse effect in their daily lives, especially on their mental health."… I gave a marriage proposal to an average-heighted, longtime friend of mine. Though he liked me, he was not ready to marry me as he presumed that I'm incapable of having sex and to bear a child…" (P10: 26-year-old women)

DISCUSSION

By using the socio-ecological model, the findings of this study were deduced. The role of family support at the level of micro system, role of welfare organization at meso system, and the policy making bodies at macro system are necessary to understand the strategies involved in eliminating the daily obstacles faced by people with dwarfism. Family is an intrinsic social institution with the capacity to influence the behavior of an individual (Aldersy2012). Thus, it is important to comprehend the everyday challenges of people with dwarfism in the context of their family ties and human relationships (Pfeifer et.al, 2021). This study revealed that persons with dwarfism, possessing a supportive family are able to overcome their day-to-day obstacles brought on by both material and intangible factors at a slightly manageable and faster pace when compared to its counterpart. Family members aid in assisting their disabled inmates by modifying the home's infrastructure in proportion to their height, like lowering the switch boards, providing accessible door handles, availability of smaller staircases, customizing the chairs and tables to their height, lowering the kitchen tabletops, availability of smaller vessels, lowering the clothesline etc. It is evident that people with dwarfism experience very minimal struggles in the areas attainable through family support such as housing pattern and infrastructural facilities at home (Baidi et.al, 2018). Another strenuous task for a person with dwarfism is to mobilize from one place to another using a vehicle (Urenev et.al, 2023). This issue can be addressed by the family members, either by arranging a vehicle comfortable for them to get onto or otherwise they can accompany them during travel. Family members must inseminate the sense of assurance by staying attentive to their emotional needs and empathizing them in every possible way, especially at the time of despair. Further dissecting the micro system, i.e., support from parents, siblings, spouse and children are all inevitable to combat the daily challenges in a constructive manner.

At the level of meso system, the welfare organization for the people with dwarfism plays an indispensable role as it aids in determining their needs, expressing their views and stand points on priorities, assessing services and public awareness (Khasnabis 2010). The results conveyed that by associating oneself with the dwarfism organization, a resource to accumulate their human capital certainly amplifies the quotient of social relationships (Machalek et.al, 2015). Moreover, studies reported that many little people had discouraging experiences of insulting and bullying for their physical appearance (Kruse 2002), which eventually made them anxious to appear in public places and that confined them to stay indoors. The welfare organization for people with dwarfism aids in eliminating the fear of being negatively evaluated and build in confidence and self-esteem. Along with the enhancement of personality, informational support with regards to education, mate selection and employment is provided (Thompson et.al, 2008). The welfare organization functions in a constructive way, as it instills the sense of assurance and hope for every member and stands by them, especially at the time of hardship. The purpose of such welfare organization is not merely for the development of a sense of communion but also alleviates the problems of physical inconvenience, by associating with people of similar issues (Weinberg, 1968).

At the macro system, efforts from policy makers to build a disability free environment and implications on strict anti-discrimination laws will certainly improve the conditions of people with dwarfism. The infrastructural barriers can be resolved by the adoption of Universal design, an approach with the principle of providing access for all types of disabled people as opposed to the current disability design imbibing only wheelchair users and visually impaired (Pritchard 2016). Universal design is based on the postulate that there exists only one population, comprising individuals with diverse attributes and therefore accommodates people with different body shapes and sizes (Iwarsson et.al, 2003). Additionally, they are discriminated by the educational institutions wherein they are denied to opt desired courses (courses like medicine, catering, disciplines that use laboratory like microbiology, chemistry, etc. - dismissed). Similar structural discrimination is evident in the employment sector where they are denied of skill-based work rather expected to do the conventional job as comedians in movies, as jokers in circus or to attract the crowd by issuing pamphlets (Pritchard et.al 2020). Such issues can be resolved by the enactment of anti-discriminatory laws in the field of education, employment, housing and in public areas. In short, the issues of people with dwarfism are often caused by societal barriers of prejudice and inaccessibility of their environments, and not by the inherent physical differences or medical issues (Hill, 1986).

CONCLUSION

Through the lens of people with dwarfism, amidst confined functional mobility, this paper revealed the limited opportunities available for accessing the amenities at public places and personal space. The societal perception, that people with dwarfism are incapable of performing certain functions and the act of treating them different from others are the predominant cause for their psycho social challenges. In a nutshell, to resolve the challenges encountered by them and to attain a living with utmost wellness, the combined efforts of the individual, family, organization and policy making bodies is essential.

LIMITATIONS

The researcher faced quite a few rejections from people with dwarfism as they were anxious and apprehensive to take part in the in-depth interview. In addition, the presence of family members and peers were unavoidable at the time of interview.

ACKNOWLEDGEMENT

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Table 1- Participant Information Sheet

Participant	Age	Gender	Marital Status	Occupational status	Level of Education
P1	32	Male	Unmarried	Employed	Higher Secondary
P2	33	Male	Married	Employed	Higher Secondary
P3	26	Male	Unmarried	Unemployed	Graduate
P4	29	Male	Married	Employed	Graduate
P5	38	Male	Married	Employed	Secondary
P6	39	Male	Married	Employed	Secondary
P7	27	Female	Unmarried	Unemployed	Graduate
P8	36	Female	Married	Employed	Graduate
P9	34	Female	Married	Unemployed	Secondary
P10	26	Female	Unmarried	Unemployed	Graduate
P11	35	Female	Married	Employed	Higher Secondary
P12	34	Female	Unmarried	Unemployed	Secondary

Table 2. Emergent themes and sub themes

Emergent Themes	Sub-themes
Underpinning challenges at private life	• Infrastructural challenges at home • Clothing-as a challenge • Cooking- as a challenge
Challenges at public space	• Infrastructural challenge at public places • Challenges in transportation • Challenge at workplace • Challenge at places of entertainment
Psycho- social challenges	• Public gaze • Appearance teasing • Stereotyping
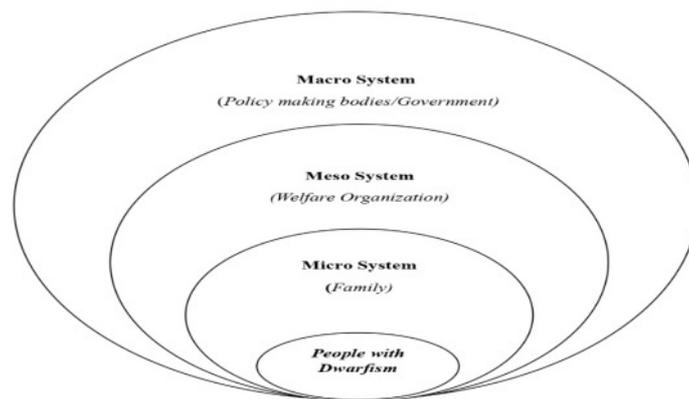
Fig. 1 – Bronfenbrenner's Ecological Model in the current study

RESEARCH ARTICLE

Prime Labeling of Corona Product of Graphs

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ABSTRACT

A graph G with vertex set annotated for the distinct vertices, f : V(G) → {1,2,3…|V| } is used to label the vertices of a graph with vertex set V in such a way that the labels given to any two adjacent vertices x and y are relatively prime, (i.e) gcd {f(x), f(y)} = 1 then it is referred to have a prime labeling. In this paper, we present results concerning prime labeling of corona product of graphs. Star Graph and Cycle graph are taken into consideration. Also, the efficiency of the labeling technique is analyzed with the example.

Keywords: Labeling, Prime Labeling, Corona Product of Graphs.

INTRODUCTION

In this paper, the finite simple undirected graph was taken into consideration. A set of vertices V(G), a set E(G) and its incidence relation make up the graph G. We refer the following book [1] for the terms used in graph theory. The term labeling was first introduced by Rosa[5] and presented several graph labeling methods. Later, Roger Entringer introduced prime labeling. [7] Tout *et.al* considered some classes of graph and identified the graphs which admits prime labeling. We have citied the survey of graph labeling by Gallian J.A[3]. In 1970, [2] Frucht and Harary introduced the corona product of graphs. They defined a new and simple operation of two graphs so that the resultant graph is isomorphic with the product of two graphs. [4] Meena.S and Naveen. J,found Corona Product of wheel Graphs with path and star graph, crown graph with path and star graph and they applied the prime labeling. [6] Thamothara Pandian *et.al*, also generated prime graphs using corona product of cycles and wheels with complete Graphs. In this paper, we proved that the graph obtained by attaching the copy of star graph $K_{1,n}$ to each vertex of cycle graph C_3 and C_4 so that the resultant is prime graph.

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Preliminaries

The basic notions, concepts and definitions are reviewed in the session.

Definition: 2.1

For a Graph G = (V, E) assigning of labels to the vertices or the edges of a graph is known as labeling. Labels are often represented by integers.

Definition: 2.2

For a graph G = (V, E) with p vertices, if the mapping f : V(G) → {1,2,3…| V| = p }are used to label the vertices of a graph with vertex set V in such a way that the labels given to distinct vertices x and y are relatively prime, (i.e) gcd {f(x), f(y)} = 1 then it is referred to have a prime labeling.

Definition: 2.3

The graph G ∘ H that results from taking one copy of G and | V(G) | copies of H and attaching the i-th vertex of G to every vertex in the i-th copy of H is known as the corona product of two graphs G and H.

Definition: 2.4

A Star graph $K_{1,n}$ is a tree with n leaves and 1 internal node. Instead, for a n - vertex graph n-1 vertices have degree 1 and one vertex has degree n - 1, making a star graph a unique class of graph.

Definition: 2.5

A graph made up of a single cycle or specifically a collection of vertices linked together in a closed chain is referred to as a cycle graph C_n

Prime Labeling Of Corona Product of Cycle and Star Graph

Theorem: 3.1

The graph $C_3 \circ K_{1,n}$ admits prime labeling if n ≥ 2.

Proof:

We consider the cycle graph of order 3 and star graph of order n + 1.

Let { v_1, v_2, v_3 } be the vertices of the cycle graph.

V (C_3) = { v_i : 1 ≤ i ≤ 3 }

Star graph vertices are represented by

$V (K_{1,n})$ = { u_i , u_i^j : 1 ≤ j ≤ n , 1 ≤ i ≤ n}

Here, { u_i } be the internal node of the star graph.

According to the corona graph specification, each vertex of $V (C_3)$ is adjacent to every vertex of a copy of $V (K_{1,n})$

As a result, the cycle and path graph's corona product yields a total number of vertices is

$V (C_3 \circ K_{1,n})$ = { v_i : 1 ≤ i ≤ 3 } ∪ { u_i : 1 ≤ i ≤ n } ∪ { u_i^j : 1 ≤ j ≤ n , 1 ≤ i ≤ n}

Therefore, the graph $C_3 \circ K_{1,n}$ has 3n + 6 vertices.

Define a labeling f : v → { 1, 2, 3, …., 3n + 6} as follows.

For 1 ≤ i ≤ n

f(v_i) = 2i - 1, f (u_i) = 2i + 5,

f(u_i^1) = 4i – 2, f (u_i^2) = 4i,

f(u_i^3) = i + 12, f (u_i^{4+j}) = i + 3j + 12

The adjacent vertices can be demonstrated as relatively prime and the numbers are labeled alternatively.

gcd (f (v_i) , f(u_i)) = gcd (2i – 1, 2i+5) = 1

since both are odd consecutive integers.

gcd (f (v_i) , f(u_i^1)) = gcd (2i – 1, 4i - 2) = 1

gcd (f (v_i) , f(u_i^2)) = gcd (2i – 1, 4i) = 1

gcd (f (v_i) , f(u_i^3)) = gcd (2i – 1, i +12) = 1

gcd (f (v_i) , f(u_i^{3+j})) = gcd (2i – 1, i+3j+12) = 1

since the two numbers are consecutive integers, the gcd of these two numbers is 1.

Thus, f is prime labeling.

Hence $C_3 \circ K_{1,n}$ is a prime graph.

Analytical Evaluation of the graph $C_3 \circ K_{1,n}$

Prime Labeling for $C_3 \circ K_{1,2}$
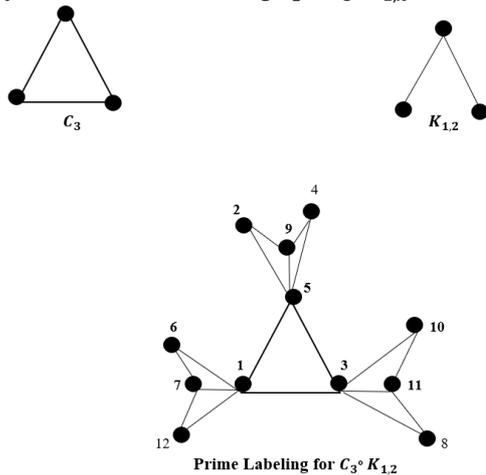
Theorem: 3.2

The graph $C_4 \circ K_{1,n}$ admits prime labeling if n ≥ 2.

Proof:

We consider the cycle graph of order 4 and star graph of order n + 1.

Let { v_1, v_2, v_3, v_4 } be the vertices of the cycle graph.

$V(C_4) = \{ v_i : 1 \le i \le 4 \}$

Star graph's vertices are represented by

$V(K_{1,n}) = \{ u_i, u_i^j : 1 \le j \le n, 1 \le i \le n\}$

Here, { u_i } be the internal node of the star graph.

According to the corona graph specification, each vertex of $V(C_4)$ is adjacent to every vertex of a copy of $V(K_{1,n})$

As a result, the cycle and path graph's corona product yields a total number of vertices is

$V(C_4 \circ K_{1,n}) = \{ v_i : 1 \le i \le 4 \} \cup \{ u_i : 1 \le i \le n \} \cup \{ u_i^j : 1 \le j \le n, 1 \le i \le n\}$

Therefore, the graph $C_4 \circ K_{1,n}$ has 4n + 8 vertices.

Define a labeling f : v → { 1, 2, 3, …., 4n + 8} as follows.

For 1 ≤ i ≤ n

$f(v_i) = 2i - 1$, $f(u_i) = 2i + 7$,

$f(u_i^1) = 2i$, $f(u_i^2) = 2i + 8$,

$f(u_i^3) = i + 16$, $f(u_i^{3+j}) = i + 4j + 16$

The adjacent vertices can be demonstrated as relatively prime and numbers are labeled alternatively.

gcd (f (v_i), f(u_i)) = gcd (2i − 1, 2i+7) = 1

since both are consecutive odd integers.

gcd (f (v_i), f(u_i^1))   = gcd (2i − 1, 2i) = 1

gcd (f (v_i), f(u_i^2))   = gcd (2i − 1, 2i + 8) = 1

gcd (f (v_i), f(u_i^3))   = gcd (2i − 1, i +16) = 1

gcd (f (v_i), f(u_i^{3+j})) = gcd (2i − 1, i+4j+16) = 1

since the two numbers are consecutive integers, the gcd of these two numbers is 1.

Thus, f is prime labeling.

Hence $C_4 \circ K_{1,n}$ is a prime graph.

Analytical Evaluation of the graph$C_4 \circ K_{1,n}$

Prime Labeling for $C_4 \circ K_{1,3}$
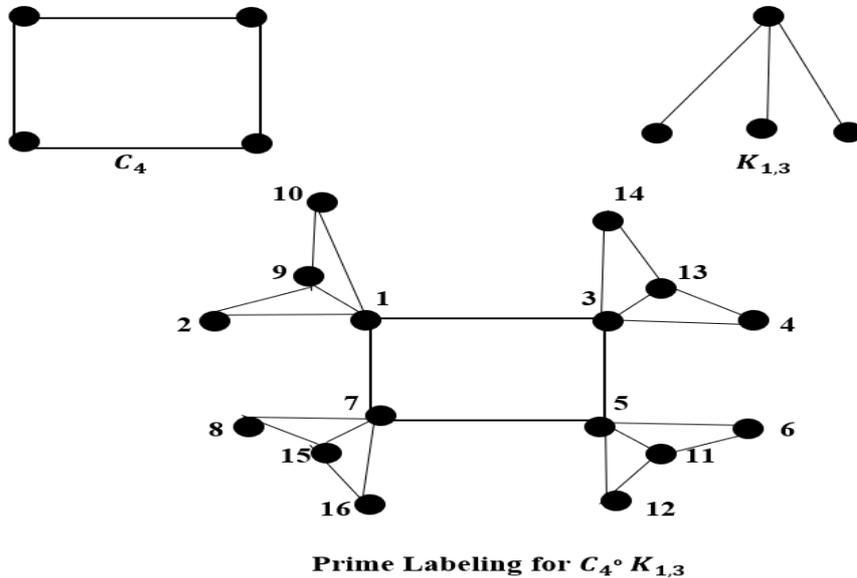
CONCLUSION

The most advantageous field of graph labeling with several applications is prime labeling. We have shown that the newly built corona product of graphs derived from cycle of order 3 and star graph of order n admits prime labeling. Moreover, we have also acquired the corona product of cycle of order 4 and star graph of order n which acknowledges prime labeling. Analysis of the labeling technique is also examined. We would also look into additional structures with prime labeling in more detail.

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RESEARCH ARTICLE

An Examination of Teaching Aptitude of Professors at Chennai's Government-Aided and Self-Financed Colleges

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ABSTRACT

Higher education institutions must focus on employee aptitude in a competitive, globalized world to ensure proper performance and delivery. In this cutthroat environment, the correct aptitude can spur progress and possibly guarantee holistic development. The teaching community has a significant role in determining the fate of both a nation and a race in addition to being viewed as a factor of production. The focus should be placed on identifying and developing the best policies and procedures to nurture, develop, and evaluate the right aptitude among employees and teachers because the right aptitude is the source of competitive advantage for the organization and higher educational institutions. The effectiveness of the instructor is also influenced by the organization's coordinated use of structure, strategy, and policy, as well as the physical and psychological environment, motivational techniques, etc. This article's goal is to compare the teaching abilities of educators working in publicly funded and independently funded institutions, as well as to emphasize the differences in teaching abilities between male and female educators. For this reason, male and female teachers in government-aided and independently funded university-affiliated colleges in Chennai, India, were surveyed using the Teaching Aptitude Test. The results of the investigation revealed that male instructors had a mean aptitude rating that was greater than that of female teachers. Additionally, male professors in government-aided colleges are more qualified than those in independently funded colleges, and vice versa for female teachers.

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Additionally, it was discovered that male and female teachers receive different results on each of the distinct aptitude components.

INTRODUCTION

According to Dave N. and Raval D. (2015), "teaching aptitude" is a state of being or a group of traits that a person possesses and that are indicative of their capacity to comprehend not only the subject matter but also the purposes and procedures of education. It indicates a person's propensity for making complex ideas clear and illuminating ambiguities. The focus should be placed on identifying and developing the best policies and strategies to nurture, develop, and evaluate the right aptitude among employees and teachers because it is the source of competitive advantage for the organization and higher educational institutions (Jan F. et al., 2015). Teachers are the foundation of education, and student's performance is heavily reliant on their ability and attitude (Lal R. and Shergil S. S., 2012). Nobody can properly fill his shoes or have the same kind of impact on kids as he can when working alone. The teachers are the center of attention, play a crucial part in the educational system, and serve as a connecting link between a country's educational system and its students. The effectiveness and productivity of the instructor, both of which are influenced by the teacher's appropriate aptitude, determine the impact of any timetable or program related to education. Teachers should be aware of their significance in the educational system, possess a proper and balanced attitude toward their work, and act as change agents. Assembling a learning society and preparing future educators to be lifelong learners are the responsibilities of teacher educators (Khan M.S. et al., 2014). However, teacher educators can only perform their duties well if their education is better and is delivered correctly.

In both government-aided and independently funded institutions, teachers should be able to work with the proper aptitude and attitude thanks to government infrastructure, policies, and plans (Jose M.M., 2008). The effectiveness of a teacher may be influenced by the organization's coordinated use of structure, strategy, and policy, as well as the physical and psychological environment, motivating techniques, and other factors (Ramon, 2017). The focus should be placed on identifying and developing the best policies and strategies to nurture, develop, and evaluate the right aptitude among employees and teachers because the right aptitude is the source of competitive advantage for the organization and higher educational institutions (John J. S., 2016). Employee performance could be viewed as a dependent variable surrounding the organization's structure, strategy, and policies, as well as the physical and psychological environment, motivating techniques, etc. Teachers should have a positive outlook on their line of work despite an uneven support structure. The active participation of instructors and faculty in higher education institutions demonstrates their interest in both teaching and learning. A teacher's positive attitude will provide the classroom a boost, ignite fresh energy, and further transform learning into an engaging and enjoyable activity.Every person has a unique point of view and ability for teaching and learning, which influences the teacher's task-related action orientation and behavior. Particularly in the national capital region of Delhi, the working environment, policies, and real working situation of government-aided and self-financed colleges differ, and this is frequently complemented by the exceptional aptitude of male and female teachers.

Objectives of the Study
The following list includes the study's key goals.
1. To assess the teaching abilities of male professors employed in government-funded and privately funded colleges in Chennai.
2. To assess the teaching abilities of female professors employed in government-funded and privately funded colleges in Chennai.

Hypotheses

H$_{01}$- In Chennai, there is no appreciable difference between male professors who work in government-aided and independently funded colleges in terms of their ability for teaching.

H$_{A1}$- In Chennai, there is a considerable disparity between the teaching abilities of male professors working in government-aided and privately funded institutions.

H$_{02}$- InChennai, there is no appreciable difference between the teaching abilities of female professors working at government-aided and privately funded institutions.

H$_{A2}$- In Chennai, there are notable differences between female professors who work in government-aided and independently funded colleges in terms of their ability to teach.

METHODOLOGY

Sampling Details

Sample Size - There were 180 respondents in the overall sample size taken into account, which was divided as follows:

Data Collection Sources

To gather data, both primary and secondary sources were utilized. With the use of research papers, journals, websites, and other pertinent published sources, secondary data was gathered.

Tool for Primary Data Collection
Brief description of TAT developed by Jai Prakash and R.P. Srivastava

Jai Prakash and R. P. Srivastava created the Teaching Aptitude Test (TAT) scale to assess teachers' aptitude, which aids in determining their suitability for the profession. To collect and analyze data, this standard scale uses the Otis and Smith approach (Kant, R., 2012). There are 15 subcategories (sub-tests) under each of the scale's 10 items. The answer was recorded using a Likert scale. The Guttman and Spearman-Brown Prophecy formulas were used to calculate the reliability of the data using the split-half approach, which produced correlation coefficients of 0.891 and 0.91, respectively. The scale has the following sub-areas as subtest

1. Cooperative Attitude,
2. Kindliness,
3. Patience,
4. Wide interest,
5. Fairness,
6. Moral Character,
7. Discipline
8. Optimism,
9. Scholarly Taste,
10. Enthusiasm.

Variables Considered

1. **Dependent Variable** - In a scientific experiment, the variable under test and being measured is known as the dependent variable. The dependent variable in the study is teaching aptitude.
2. **Independent Variables** –To compare a feature to another variable, it draws attention to or makes references to those that the researcher or investigator is either controlling or observing. Gender is one of the independent factors in the study.

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Data Analysis
Male Teachers
In accordance with the above table.
1.   A government-aided college's male professors' median score was found to be 192.47.
2.   Male instructors at self-financed colleges had a mean value of 184.31.
3.   A government-aided college's male teachers' S.D. value was discovered to be 49.6.
4.   It was discovered that the S.D. value for male professors at government-aided colleges was 27.2.
5.   The degree of freedom was 48.

The null hypothesis is rejected and the alternate hypothesis, which states that there is a significant difference in the teaching aptitude of male teachers in government-aided and self-finance colleges, is accepted. The calculated values of t are compared to the values that are tabulated values of t and it is found that at 0.01 level of significance, the values are significant. After data analysis, it was discovered that there is a substantial difference in mean and standard deviation, indicating that male teachers' aptitude for teaching is stronger in a self-financed institution than in a government-aided college.

Chart Showing Component Wise Teaching Aptitude of Male Teachers
After examining the aforementioned table, it was discovered that men who teach in self-financed colleges are more intensive in terms of fairness, a cooperative attitude, discipline, and optimism than men who teach in government-aided universities, as evidenced by the higher mean scores that were obtained in the aforementioned circumstances. However, because their mean scores are comparably higher in the corresponding components, the male teaching staff at government-aided colleges are intense in terms of patience and extensive interest in their subject matter.
According to the previous table

1.   It was shown that female lecturers at government-aided colleges had a mean value of 175.27.
2.   It was shown that female lecturers at self-financed colleges had a mean value of 180.17.
3.   Female professors at government-aided colleges were found to have an S.D. Value of 55.26.
4.   Female teachers at Government-aided Colleges were found to have an S.D. value of 36.33.
5.   It had 128 degrees of freedom.

The null hypothesis is rejected and the alternate hypothesis, which states that there is a significant difference in the teaching abilities of female teachers in government-aided and self-finance colleges, is more likely to be accepted. The calculated values of t are compared to the values that are tabulated values of t, and it was found that at the 0.01 level of significance, the values are significant. The examination of the data revealed that there is a substantial difference in the means and standard deviations, which suggests that female professors' teaching abilities are more intensive in self-financing colleges than in government-aided colleges.

Chart Showing Component wise teaching Aptitude of Female Teachers
After data analysis, it was discovered that female teachers in self-financed colleges are more intense in terms of Moral Character, Scholarly Taste, Fairness, Enthusiasm, and Wide Interest because their recorded mean scores are higher than those of female teachers in government-aided colleges, whereas female teachers in government colleges are more intense in terms of Kindness, Patience, and discipline. After all, their recorded mean scores are higher.

FINDINGS

According to the study, it was discovered that male professors in government-financed universities have much higher teaching aptitude than their counterparts who work in a self-financed system. In the case of female teachers, the reverse was discovered. Moral character, discipline, optimism, cooperation, and fairness were attitude traits that male teachers in government-aided colleges scored higher on than those in self-financed colleges. They performed

worse than self-financed colleges in terms of friendliness, intellectual qualities, and enthusiasm, nevertheless. There isn't much of a difference in terms of wild interest. When compared to female teachers at government-funded institutions, self-financed college teachers had much higher moral character, academic taste, excitement, fairness, and crazy interest. However, compared to their counterparts at independently funded colleges, the abilities of female professors in government-aided colleges are more significant in terms of qualities like Kindness, Cooperation, and Discipline.

The study's findings could lead to the following inferences:
1. Male professors in Chennai who work in government-aided and independently funded colleges have quite different teaching styles.
2. The teaching abilities of female professors employed at government-supported and privately funded colleges in Chennai vary significantly.
3. Due to awareness, flare, and competition to survive, male professors' teaching abilities are more intense at self-financed colleges than in government-aided colleges.
4. In self-financed colleges compared to government-aided colleges, female professors' teaching aptitude is more intense, mostly because of their enhanced scholastic interests, capacity for learning, and lucidity.

Limitations of the Research
1. Only Chennai was taken into consideration, hence the outcomes and conclusions may differ in other areas.
2. Teachers' teaching aptitude was the only element taken into account for the current study, while actively taking into account additional factors could enhance the results.
3. No other higher education institutions, such as universities or independent institutions, were used to choose the sample of teachers; only degree-granting institutions linked with universities were considered.
4. The sample size had a considerable bias in favor of female teachers.

CONCLUSIONS

Teaching is a way to achieve perfection rather than just a way to make a living. A nation's and society's future is primarily dependent on education, and teachers must play a vital role in ensuring that it is both sustainable and successful. An updated and rigorous aptitude is required along with all other essential elements like knowledge, intelligence, and communication to increase the quality of instructors. Teaching is a dynamic process that needs to be developed in accordance with the changing needs and demands of society and pupils. With positive aptitude, teachers can turn a process of learning into sustainable learning, strengthening the social fabric in the process. Although there are many aspects that determine teaching ability, values, beliefs, and attitudes shape it. Both male and female teaching staff must possess the necessary teaching aptitude because a teacher with the appropriate aptitude can adopt the proper methodology and can influence the destiny of the country. Additionally, male teachers who work in self-financed colleges are more intense in terms of the components of fairness, cooperation, discipline, and optimism, whereas male teachers who work in government-aided colleges are more intense in terms of patience and broad interest. In terms of moral character, scholarly taste, fairness, enthusiasm, and wide interest, female teaching staff members working in self-financed colleges are more intense (as their horizon for learning, enthusiasm towards teaching and learning, scholarly taste, and cooperative attitude are intense), whereas female teaching staff members working in government-aided colleges are more intense in terms of kindness, patience, and discipline.

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Table 1: Break up of Respondents

S.No:	Nature of College	Number of Male Teacher Respondents	Number of Female Teacher Respondent	Total
1.	Government aided	27	63	90
2.	Self Financed	23	67	90
	Total	50	130	180

Table 2. Sampling Frame

S.No:	Items	Sampling Technique
1.	Selection of the Field of Study	Convenience and Judgmental
2.	Selection of respondents	Simple Random

Table 3. Tool for Primary Data Collection

S.No:	Item	Scale Used
1.	Teaching Aptitude	TAT developed by Jai Prakash and R. P. Srivastava

Table 4.Teaching Aptitude of Male Teachers

Nature of College	N	Mean	S.D.	df	`t` value
Government - aided	27	192.47	49.6	48	3.2099**
Self Financed	23	184.31	27.2		

(** Level of Significance @ 0.01)

Table. 5: Component-wise teaching Aptitude of Male Teachers

Component	Nature of College	N	Mean	S.D	df	`t` value
Cooperative Attitude	Government- aided	27	21.63	9.62	48	10.94**
	Self Financed	23	16.26	8.76		
Kindliness	Government- aided	27	17.80	8.48	48	6.53**
	Self Financed	23	20.17	8.39		
Patience	Government- aided	27	15.97	11.19	48	1.31
	Self Financed	23	16.81	13.32		
Wide interest	Government- aided	27	20.23	8.53	48	1.53
	Self Financed	23	17.52	8.72		
Fairness	Government- aided	27	22.06	9.31	48	1.81**
	Self Financed	23	22.17	8.46		

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Moral Character	Government- aided	27	19.43	9.15	48	6.05**
	Self Financed	23	16.83	6.9		
Discipline	Government- aided	27	18.93	9.71	48	5.21**
	Self Financed	23	16.57	7.17		
Optimism	Government- aided	27	20.23	10.07	48	4.56**
	Self Financed	23	17.96	8.47		
Scholarly Taste	Government- aided	27	16.53	9.35	48	3.25**
	Self Financed	23	18.27	8.46		
Enthusiasm	Government- aided	27	15.67	10.23	48	4.83**
	Self Financed	23	19.38	10.44		

(** Level of Significance @ 0.01)

Table 6: Teaching Aptitude of Female Teachers

Nature of College	N	Mean	S.D.	df	`t` value
Government - aided	63	175.27	55.26	128	3.905**
Self Financed	67	180.17	36.33		

Table 7: Component wise teaching Aptitude of Female Teachers

Component	Nature of College	N	Mean	S.D	df	`t` value
Cooperative Attitude	Government- aided	63	17.63	9.62	128	15.94**
	Self Financed	67	14.26	8.76		
Kindliness	Government- aided	63	30.80	8.48	128	76.53**
	Self Financed	67	17.17	8.39		
Patience	Government- aided	63	16.97	11.19	128	13.31**
	Self Financed	67	12.81	13.32		
Wide interest	Government- aided	63	28.23	8.53	128	15.53**
	Self Financed	67	12.52	8.72		
Fairness	Government- aided	63	18.06	9.31	128	12.23**
	Self Financed	67	20.17	8.46		
Moral Character	Government- aided	63	17.43	9.15	128	8.25**
	Self Financed	67	19.83	6.9		
Discipline	Government- aided	63	18.93	9.71	128	4.21**
	Self Financed	67	17.57	7.17		
Optimism	Government- aided	63	17.23	10.07	128	1.66**
	Self Financed	67	17.96	8.47		
Scholarly Taste	Government- aided	63	15.53	9.35	128	8.45**
	Self Financed	67	17.27	8.46		
Enthusiasm	Government- aided	63	15.67	10.23	128	12.83**
	Self Financed	67	19.38	10.44		

(** Level of Significance @ 0.01)

RESEARCH ARTICLE

6G through Artificial Intelligence: A Vision

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ABSTRACT

In today's society, wireless communication technologies are crucial for applications in entertainment, commerce, health, and security. With each iteration, these systems have improved, and currently fifth generation (5G) wireless networks are being introduced globally. Due to its usage of higher frequency bands on the wireless airwaves than 5G, 6G is anticipated to theoretically offer maximum speeds up to 100 times faster than those of 5G. The application of artificial intelligence (AI) to such wireless networks is one of the essential elements of 6G technologies. This paper shares the knowledge about new scenarios of 6G beyond 2030, Architecture of 6G and future research directions in 6G. Finally, discussed ongoing 6G Projects.
Keywords: 5G, 6G, Artificial Intelligence.

INTRODUCTION

Sixth Generation (6G) is a new wireless technology that has attracted many scholars and researchers. A major promise of 6G is to extend the benefits of AI and ML to wireless networks and users. 6G will also use AI and ML techniques to deliver advances in technological metrics such as higher throughput, support for new high-demand applications, and enhanced use of radio frequency bands [W. Saad F. Tariq, 2020] · M Z. Chowdhury] One of the most important AI technologies envisioned as a key technology for 6G will be DL as it has powerful applications to achieve learning from more human-like scenarios. However, this article provides an overview of broad categories of AI techniques, including DL, and their potential role in future he 6G communication systems. The current growth in data size and usage has prompted many researchers to focus more on meeting latency and energy targets by improving existing wireless systems in various aspects. [W. Saad et al., 2020].

New Scenarios of 6G Beyond 2030
By 2030, new application scenarios will proliferate. Scenarios fall into three categories: Intelligent Production, Intelligent Life, and Intelligent Society. Typical use cases beyond 2030 (Sodhro et al., 2020; Khan et al., 2020).

Intelligent production
The digital economy has the potential to expand through the application of developed technologies in agriculture and industry. 6G will enable intelligent manufacturing through computerization. For example, drones are used in agriculture. Robotics and virtual reality improve production efficiency. With modern technologies such as the digital twin, 6G will enable smart manufacturing more importantly.

Smart Life
Twin Body Area Network with the internet and intelligent interactions could change our lives in 2030 such as smart home, smart bank etc.

Smart Society
Ubiquitous coverage networks in 2030 will greatly expand public service coverage and bridge the digital divide between sectors. Overall, 6G networks will enhance social governance and provide a solid foundation for a better society. Figure 1 shows a new scenario occurring in 6G networks. Table 1 demonstrate the 6G advantages compare to 4G and 5G.

Architecture of 6G
The ecosystem is expected to create new demands for both KPIs and KVIs to support a variety of new use cases while 6G architecture best supports existing use cases. To meet these needs, 6G architectures are expected to evolve in six key areas (Figure 2) [G. Kunzmann et al., 2022].

Flexibility
6G architecture should be more flexible in various dimensions. The 6G architecture must work in both large wide area network deployments and very local on-premises and personal area networks. Second, in terms of feature placement, 6G architectures are expected to meet various latency targets and meet other requirements dynamically. For example, supporting XR services requires ultra-low latency for specific users in limited regions and timeframes. For example, the ability to scale dynamically is essential to accommodate changing network loads.

Specialization
Given the variety of use cases and deployments, the 6G architecture should be able to offer customized functionality. For example, a particular 6G subnet, a lightweight sensor network, or some extreme network use case may require a particular set of features, but leave out other features that are not required for that type of network.

Robustness and Security
Users in vertical industries expect network services to be delivered in a robust, resilient and truly ubiquitous manner that allows for multi-connectivity as needed. Also short-range terahertz cellules network architecture and non manner terrestrial network architecture (NTN). Another major security goal is meeting high expectations in terms of trust and data protection.

Cloud platform
The ongoing shift to hosting network functions on cloud platforms will continue and grow. Deployments are moving significantly from specialized telecom cloud platforms to general-purpose public, private, or hybrid clouds on-premises, at the (far) edge, or in central locations. 6G will provide a unified orchestration interface for distributed

cloud service management, complemented by segment-specific abstractions. B. For 6G RAN. This enables special features in cloud nodes, such as: B. Hardware Acceleration.

Programmability

Implementations should also reach new levels of programmability, like hardware-agnostic programming languages like P4, and run on any cloud platform. Serverless services and multi-vendor capabilities are easier to integrate with open, service-based interfaces and a more modular system design. This allows you to provision networks or instantiate network slices with exactly the features and services you need.

Simplicity and sustainability

At the same time, we expect more from our network, so we must also consider ways to simplify our architecture. The complexity and number of functions within the system have increased in past generations. While stronger zero-touch automation capabilities provide the means to address system complexity, the advent of 6G will force us to rethink architectures, removing, redesigning, or consolidating functionality in favor of service-based applications. It also provides opportunities. It also acts as a control plane between the radio access network (RAN) and the core network, simplifying signaling procedures along with distributed non-access stratum (NAS) interfaces. Another example is creating a tailor protocol stack to enable efficient integration of his customer-specific 6G subnets. Simplifying the placement of functions and providing more flexibility and dynamism also helps achieve sustainability goals by reducing signal volume and power consumption. A clear commitment to "designing for sustainability" will be important in 6G. Artificial intelligence and machine learning techniques are expected to be an integral part of the 6G architecture. This is the technology needed to realize the vision of a truly cognitive network that adapts to different scenarios and deployments. AI/ML is expected to play a key role in automating and optimizing networks and improving system security. For widespread use of AI/ML, the architecture includes functions and interfaces for large-scale data acquisition, processing and distribution, training to improve models, and updating inference models within functions is needed. [G. Kunzmann et al., 2022].

End-to-end 6G architecture view

Figure 2 shows the planned end-to-end (E2E) 6G architecture. The infrastructure resource layer provides physical resources for hosting network functions and services. This layer includes all switches, routers, transport links, data centers, cloud infrastructure, radios, and non-virtualized radio functions such as Radio Units (RUs), Distribution Units (DUs), Base Stations, etc. is also included. The Network Services Layer is expected to be fully cloud-based and is grouped into Far Edge, Edge, Core/Central, and Public/Private Clouds to cover a wide variety of clouds that can be deployed by multiple stakeholders. doing. The far edge is characterized by the heterogeneity of devices with different software and hardware technologies, such as personal devices and IoT devices. It provides a public framework that establishes control channels across multiple clouds and enables seamless collaboration and networking. By implementing all network functions, operations and applications as services, the 6G architecture will be software-based, intelligent and efficient. Applications running on 6G systems require communication and computing services with specific QoS and QoE requirements that can be provided by dedicated network slices. There is a gradual move toward increasing levels of automation and using fully automated closed-loop control. This is supported by the parallel adoption of advances in AI/ML technology. Overview of 6G Architectural Innovations This section discusses some of the architectural innovations that should be considered to achieve his 6G design goals mentioned above.

These innovations span all layers of the 6G system and include 6G hardware platforms, common cellular network functions, specializations for specific use cases and requirements, and orchestration layer components, as shown in Figure 3. It consists of functions. After briefly discussing the architectural innovations, we will introduce some of them in more detail. From a platform perspective, we envision a heterogeneous distributed cloud environment. H. 6G networks can span multiple clouds in different locations and involve multiple stakeholders. Cloud capabilities such as hardware acceleration will become essential components for integration. B. To support cloud-native

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implementation of deep learning processing and lower-layer RAN functions.At the functional level, new functional partitions within the RAN can be designed between the RAN and core network functions, with the aim of enabling optimized UE RAN core architecture design. This simplifies the steps involved and consolidates similar functionality. Possible solutions range from simply extending existing interfaces to breaking domain isolation entirely, or anything in between. Dynamic and adaptive feature placement can best address the trade-offs between network performance, complexity, power consumption, and most importantly service and consumer requirements. At the same level, we also expect changes to the vast amount of data and information that will be collected, stored, and made available, including AI/ML-powered analytics at all levels of mobile networks.

Data is created and collected in multiple areas and layers of the network and can be delivered wherever it is needed. Thus, a common framework for disclosure, registration, detection, and delivery of different types of data, such as real-time streaming data, status data from various registrars' services, and data accumulated for training ML models. I believe it is necessary. The convergence of networks and computers is also being considered. In this context, it is important to ensure privacy and provide reliable solutions [Gilberto Berardinelli, 2021].

Impact of 6G
6G technology, which is still in the early stages of research and development, is expected to bring about significant advancements in wireless communication beyond 5G. When combined with artificial intelligence (AI), 6G has the potential to have a profound impact on various aspects of society and technology. Here are some potential impacts of 6G through AI

Ultra-Fast Data Transfer
6G is expected to provide ultra-high data transfer speeds, potentially reaching terabits per second. When combined with AI,this could enable real-time processing of massive datasets, benefiting applications in healthcare, autonomous vehicles, and scientific research.

Low Latency
6G aims to reduce latency to a minimum, making real-time communication nearly instantaneous. AI-powered applications, such as remote surgery or autonomous drones, could operate with minimal delay, enhancing their capabilities.

AI-Enhanced Network Management
AI algorithms can optimize 6G networks for efficient resource allocation, network slicing, and self-healing in the case of network failures. This could lead to more reliable and resilient communication networks.

AI-Driven IoT
6G is expected to support a massive number of IoT devices. AI can be used to manage and analyze the data generated by these devices, making them more intelligent and responsive to user needs.

Enhanced AR and VR
6G's high-speed, low-latency connectivity combined with AI can enhance augmented reality (AR) and virtual reality (VR) experiences. This could revolutionize gaming, education, training, and teleconferencing.

AI-Powered Smart Cities
6G can enable the development of smart cities with interconnected infrastructure. AI can optimize traffic management, energy consumption, and public services, leading to more sustainable and efficient urban living.

AI-Driven Health care
Telemedicine and remote healthcare services could benefit from 6G's capabilities, with AI enabling remote diagnostics, patient monitoring, and personalized treatment recommendations.

AI for Disaster Management
AI can analyze data from various sensors and sources in real-time to improve disaster prediction, response, and recovery efforts, leveraging 6G's connectivity.

AI in Education
With 6G's high-speed internet, AI-powered personalized education platforms can become more accessible, offering immersive and interactive learning experiences.

AI-Enhanced Security
6G networks will need robust security measures. AI can assist in threat detection and prevention, ensuring the integrity and confidentiality of data transmitted over 6G networks.

Environmental Monitoring
6G combined with AI can be used for advanced environmental monitoring, aiding in climate research and conservation efforts

AI-Driven Robotics
High-speed, low-latency 6G networks can enable remote control and coordination of AI-driven robots in various fields, including manufacturing, agriculture, and healthcare. It's important to note that the full realization of these impacts will depend on the successful development and deployment of 6G technology, as well as the integration of AI into various applications. Additionally, ethical and privacy considerations will be crucial when implementing AI in conjunction with 6G to ensure responsible and secure use of these technologies.

Challenges of 6g Through Artificial Intelligence
The integration of 6G technology and artificial intelligence (AI) presents several challenges that need to be addressed for the successful deployment and utilization of these technologies. Here are some of the primary challenges

Technical Complexity and Innovation
Developing and implementing 6G networks with AI capabilities is a highly complex task. These networks will require entirely new infrastructure, including advanced hardware, software, and communication protocols. Continuous innovation is needed to make these technologies practical and efficient.

Network Reliability
Ensuring the reliability and availability of 6G networks is crucial. AI applications heavily rely on real-time data and low latency, making network downtime or disruptions unacceptable, particularly in critical applications like healthcare and autonomous vehicles.

Data Privacy and Security
With the proliferation of AI-driven devices and applications in 6G networks, there will be an increased volume of sensitive data in circulation. Protecting this data from cyber attacks, data breaches, and unauthorized access is a significant challenge that requires robust security measures and encryption.

Ethical Considerations

The use of AI in 6G networks raises ethical concerns, such as algorithmic bias, transparency, and accountability. Ensuring that AI is used responsibly and ethically in applications like autonomous systems and decision-making processes is essential.

Regulatory Frameworks

Policymakers and regulatory bodies will need to adapt and develop new regulations to address the unique challenges posed by 6G and AI. Balancing innovation with the protection of individual rights and societal interests is a complex task.

Spectrum Allocation

6G technology will require access to new frequency bands, and spectrum allocation must be coordinated globally. Ensuring fair allocation while avoiding interference with other services and technologies is a significant challenge.

Energy Efficiency

The development and operation of 6G networks with AI can be energy-intensive. Ensuring energy efficiency and sustainability will be crucial to minimize the environmental impact of these technologies.

Digital Inclusion

Bridging the digital divide and ensuring that the benefits of 6G and AI are accessible to all, regardless of location or socioeconomic status, is a challenge. Expanding network coverage and affordability will be essential.

Interoperability

Ensuring that different components and devices in the 6G ecosystem can work seamlessly together is a technical challenge. Developing common standards and protocols for interoperability is critical.

Human-AI Collaboration

Determining the appropriate roles and responsibilities of humans and AI systems in various applications, such as healthcare, education, and transportation, will be a challenge. Striking the right balance to optimize collaboration is crucial.

Workforce Skills

As AI becomes more integrated into various industries through 6G, there will be a need for a workforce with new skills and capabilities. Preparing the workforce for this transition is essential.

Environmental Impact

The development and deployment of 6G and AI technologies may have environmental impacts, such as increased energy consumption and e-waste. Mitigating these impacts and pursuing sustainable practices is important. Addressing these challenges will require a collaborative effort among governments, industry stakeholders, researchers, and organizations. It will also require ongoing research, innovation, and a commitment to responsible and ethical use of 6G and AI technologies.

FUTURE RESEARCH DIRECTIONS IN 6G

In this section, future research scopes of 6G are discussed.

Machine learning applications

Algorithms Machine learning is an important area for 6G, so different machine learning algorithms should be studied to study their impact on different performance factors for 6G. Generalizing the machine learning process

does not yield satisfactory results for data that is frequently added to applications. Prioritized federated learning should be kept on the list of top priorities for machine learning applications, but it also suffers from fairness issues [L. Loven et al., 2019], [F. Tariq et al., 2019] . Transfer learning can be an efficient approach to adapt 6G systems to the wireless environment [B. Li et al., 2019].

Scalable and Reliable Blockchain-Enabled 6G

We typically use block chain in 6G for secure storage in various smart services such as immutable ledgers and distributed transactions [H.-N. Dai et al., 2019]. Block chain is also used in various smart services such as healthcare, smart supply chain management, etc. 6G technology enables ultra-low latency and low power consumption while maintaining security perspective. We also want to improve the scalability and reliability of the 6G system. Block chain can be an efficient tool to address all the above features while addressing privacy concerns [L. Loven et al., 2019].

Meta-learning-enabled 6G

I would like to experiment with a specific machine learning technique or algorithm for 6G applications. In this case, meta-learning provides a machine learning model that learns metadata for machine learning-based experiments. We aim to fuse general machine learning and meta-learning. This may lead to smarter technologies for his future 6G applications and wireless cellular technology development [L. Loven et al., 2019].

Cloud-based architecture and technology

Fundamentally, 6G is an edge-centric, data flow-based technology. The chain of network functions and services is dynamically determined based on the optimal balance of consumed and available resources in the cloud network. The system should be based on a combination of various machine learning approaches in a cloud environment. It also focuses on the privacy and security of datasets used in technology [L. Loven et al., 2019].

Terahertz frequencies to boost data rates

To improve the data rate for 6G applications and high data rate is one of the most important requirements for his 6G. To do this, we use the frequency band above 52.6 GHz at ultrafast rates of 100 Gbps and above [M. Shafi et al., 2017]. Use the THz band to improve spectral efficiency and mitigate free-space losses, molecular absorption, etc. [M. Shafi et al., 2017], [H. Wang et al., 2014]. Also, integrating a large number of antennas can improve the signal-to-noise ratio (SNR), so the range of power efficiency needs to be better controlled. By applying multiple-input multiple-output (MIMO) configuration, cost-effective high data rate deployment can be achieved in a wide range of 6G networks [40]. We should also be concerned with electromagnetic fields and bio-aware jet flow fields [H. Wang et al., 2014].

AI-based Edge Computing

Mobile computing, which is also used in 5G, cannot keep up with the increased data processing. Therefore, mobile edge computing is gaining tremendous momentum because it can partition the network into cloud computing architectures. There is a need to reduce latency in 6G networks with easy access to cellular networks [F. Tang et al., 2020]. To use more AI throughout the end device or 6G technology process. Also noteworthy are the offline computing capabilities using machine learning techniques [F. Tang et al, 2020] that enable intelligent allocation and offloading of resources in the cloud and at the edge. The application/dataset into mini-batches and use a central controller that helps map across multiple processing devices [F. Tang et al, 2020] at the edge or in the cloud. In real-time communication, clouding (or edge clouding) is expected as a technical goal for 6G connectivity. The use of AI and the impact of reusable data can reach new promising economic scales and many other new areas. Learning-based online connections between the various components of the 6G framework should be built. In agriculture and industry, 6G intelligently handles production generation and enhances secure and very fast connections between different modules. 4.7. Use of Location Based Intelligent Systems (LIS). LIS-based mmWave systems can be used as locations for 6G designs. Now we want to find the best place where we can race reflections and meta surfaces. This

task is very difficult and an inverse channel modeling problem. On the other hand, efficient use of materials in LIS needs to be studied [M. Piran et al., 2019].

6G PROJECT
This section selects major 6G projects that have recently been launched and describes the goals, objectives, and achievements of each project.

Hexa X Project
One of the major 6G projects to start in 2021 is Hexa-X. Nokia launches Hexa-X with Ericsson (Ericson et al., 2021). In this project, various research institutes and universities collaborate to put the latest technology into practical use. These include Dresden, Pisa, Aalto, Turin, Ol, Chalmers, Madrid and Kaiserslautern. Other commercial partners include Qacom, Networks, wings ICT Solutions, bcom, Atos, Intel and Siemens, with TIM, Orange and Telefonica believed to be running the project. The Hexa-X project aims to lay the foundation for 6G networks by 2030 and advance global research and innovation (R&I) into the next generation. The Hexa-X project aims to develop the tools necessary to bring the next generation of wireless communications to Europe and beyond. The project seeks to introduce new 6G technologies and strategies to address six main challenges. We present the most important 6G challenges.

Here is the Hexa-X project:

- Connect Intelligence: Human-to-device communications must leverage new technologies such as artificial intelligence (AI) and machine learning (ML) to improve the quality and efficiency of communications.
- Network of networks: The digital ecosystem requires the establishment of an integrated network of networks. Ideally, this network should be versatile, intelligent, and scalable.
- Sustainability: A sustainable network requires efficient use of resources. • Global service coverage: Global and extensive coverage of 6G networks requires the development of cost-effective and practical approaches.
- Best experience: New network services require high data rates, low latency, massive capacity, and precise location technology.
- Reliability: Next-generation systems must provide data protection, communication integrity, confidentiality, and resilience for advanced security.

Network design, artificial intelligence-driven air interfaces, THz radio access, and network virtualization are being developed to address these issues. This project will focus on connecting the physical, digital, and human worlds using these state-of-the-art communication methods. Hexa-X plans to develop precise location, survey and resource management methods.

DEDICAT6 project
The 6G project "Dynamic Coverage Extension and Distributed Intelligence for Human Centric Applications with 6G with Guaranteed Security, Privacy and Trust" (DEDICAT6) will start in 2021. The project involved several countries such as Greece, Finland, France, Spain, Great Britain and Germany. DEDICAT6's main goal is to transform 5G into a smart platform like 6G. The vision of this intelligent platform is to improve resource utilization, reduce latency, reduce energy consumption, minimize capital and operating expenses (CAPEX/OPEX), and improve security, trust, and privacy. problem should be strengthened. The project addresses four cases including smart highways, smart warehouses, public safety, and enhanced experiences (Srinati et al., 2021). The DEDICAT6 project uses block chain and AI technology to build an intelligent connected platform. The platform allows you to combine your current infrastructure with non-traditional infrastructure. New infrastructure must be intelligent, flexible, support real-time, and energy efficient. This project introduces new techniques using predictive caching and intelligent compute placement for intelligent dynamic resource connection distribution. DEDICAT6 also attempts to develop and design dynamic range extension mechanisms that take advantage of connected devices.

vehicles, drones, robots, etc. These devices cover areas that cannot be quickly accessed in the event of additional temporary capacity for infrastructure, emergencies, or special events. Additionally, many factors need to be considered, such as: B. Device locations and charging station locations for optimal placement and distribution of devices. It also covers mobile service security, reliability assurance, data protection, and the interface between digital ecosystems and human interaction. The project aims to significantly improve resource management, connectivity scaling, security, intelligent network load balancing, and human-machine interaction. A project platform defines several solutions for achieving project goals.

RISE 6G Project

In January 2021, Reconfigurable, Intelligent and Sustainable Environment for 6G Wireless Networks was launched as one of the leading technologies (RISE 6G). Seven countries and 13 partners will adopt RISE-6G. We are proud to have CEA-Leti as one of his strategic partners. This project will continue for the next three years (Di Renzo et al., 2019). The RIS (Reconfigurable Intelligent Surfaces) technology used in RISE-6G is one of the most promising future technologies. The dynamic and targeted control of radio wave propagation enables the perception of the wireless environment as a service. RIS technology creates an intelligent, sustainable and adaptive wireless environment. A total of four challenges are the focus of the project (Liaskos et al., 2018). First, real signal propagation is simulated. It is then integrated into RIS's various new network architectures. Third, numerous use cases have been developed to enable QoS in dynamic wireless programmable environments such as: B. Precise localization, green communication, power consumption, and huge capacity. Fourth, we need to ensure specific rules for airwaves and data security. Devices connected to high-capacity areas are dynamically managed with RIS-enabled settings to minimize power consumption and avoid interference. This project contributes to standardization and brings its technical perspective to the implementation of the project in the industrial field. As a result, Europe maintains technical leadership in his B5G/6G race globally, enabling the development of new European-designed services and economic opportunities.

Meta Project

Meta Wireless is another EU-funded project. This project paves the way for the next generation of his 6G and beyond wireless networks. Most wireless network systems typically assume that the propagation radio channel characteristics are static in nature. Subsequent generations of wireless networks regard the channel as an uncontrollable element (Chirivella-Perez et al., 2021). Meta Wireless treats the environment as a quantity to improve and optimize network performance. RIS has been deployed to operate wireless environments (Hussein et al., 2019). RIS is a planar structure of meta materials and is electromagnetically discontinuous. They do not contain the traditional laws of diffraction and reflection. However, it can be controlled to adjust the phase and wave front of the radio wave. When used to coat objects, walls, or building facades, it allows real-time tuning of the electromagnetic response of the environment. The integration of RIS and wireless networks saves more energy, improves network security, and increases system design freedom. Meta Wireless develops algorithms, theoretical frameworks, optimization protocols, and key foundations for RIS applied to network architectures. Additionally, an open access simulator is designed for network optimization. The simulator analyzes ray tracing modules, creates RIS environments, and tests large-scale RIS environments (Ali et al., 2021).

6G Brains Project

Today's large-scale industrial tasks, services, facilities, and devices of the future require innovative wireless connectivity systems. These intelligent wireless connectivity systems need to be unlocked by new spectrum resources and AI systems to fully manage network resources. The project "Bringing Reinforcement Learning Into Radio Light Network for Massive Connections (6G BRAINS)" (Shi et al., 2021) aims to develop AI at multiple decision-making levels for future industrial applications of large scale and varying requirements. Develop a driven self-learning platform. , such as large-scale connectivity via device-to-device (D2D) (Hady et al., 2020). This AI system is designed to dynamically allocate resources to new frequency links such as THz and optical wireless communications (OWC). The system also aims to increase network reliability and capacity, improve location accuracy and reduce end-to-end delay. The project is said to be the first to propose a new deep reinforcement learning (DRL)-based cross-layer

solution to support 6G requirements. This project aims to set a basic standard for B5G and 6G AI technology. This project aims to create a solid foundation and global standardization of his B5G and 6G technology in areas related to industrial environments. Project solutions aim to transform traditional systems into smart and intelligent systems such as smart factories and smart transportation systems.

These systems have less static intelligent elements. For example, buildings are considered fixed elements, but they are intelligent and flexible. In these new environments, any device can be wireless and routed using 3D SLAM mechanisms. 6G BRAINS Multi access Edge Computing (MEC) develops predictive mechanisms that are updated as in the case of maintenance of old machines. In addition, modeling of his D2D cluster using AI system is developed to improve resource sharing in his OWC band and 200 GHz and 300 GHz bands of 6G BRAINS. This modeling is important to enable the use of THz and OWC in his 6G in industrial environments. The 6G BRAINS solution (Nayak and Patgiri, 2021) also aims to reduce latency, increase availability of high-capacity communication services, extend coverage areas for indoor, outdoor, and indoor/outdoor environments, and concurrent non-real-time transmission. Real-time streaming of data and critically important data. Finally, this project studies device mobility. It seeks to extend the coverage of all connected devices in different scenarios in every location, such as factories and factories.

CONCLUSION

5G technology is not enough to meet the growing communication needs. To satisfy the communication technology needs of this new era, it is therefore vital to plan for the implementation of 6G networks. The development of communication networks from 1G to 5G, research activities on 6G mobile networks, enabling technologies for 6G networks, and the current state-of-the-art are all covered in this paper's thorough overview of the 6G wireless generation networks. The paper shown the architecture and end to end 6G architecture view of the upcoming 6G technology. 6G current projects are discussed and future research ideas are tinted for the researchers.

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Table 1. Comparison of 4G, 5G and 6G

KPIs	4G	5G	6G	KPIs	4G	5G	6G	KPIs	4G	5G	6G	KPIs
Peak data rate /device	1 Gbps	10 Gbps	1 Tbps	Peak data rate /device	1 Gbps	10 Gbps	1 Tbps	Peak data rate /device	1 Gbps	10 Gbps	1 Tbps	Peak data rate /device
latency	100 ms	1 ms	0.1 ms	latency	100 ms	1 ms	0.1 ms	latency	100 ms	1 ms	0.1 ms	latency
Max. spectral efficiency	15 bps/Hz	30 bps/Hz	100 bps/Hz	Max. spectral efficiency	15 bps/Hz	30 bps/Hz	100 bps/Hz	Max. spectral efficiency	15 bps/Hz	30 bps/Hz	100 bps/Hz	Max. spectral efficiency
Energy efficiency	< 1000 x relative to 5G	1000 x relative to 4G	>10x relative to 5G	Energy efficiency	< 1000 x relative to 5G	1000 x relative to 4G	>10x relative to 5G	Energy efficiency	< 1000 x relative to 5G	1000 x relative to 4G	>10x relative to 5G	Energy efficiency
Connection density	2000 devices / km2	1million devices /km2	>10million devices/km2	Connection density	2000 devices / km2	1million devices /km2	>10million devices/km2	Connection density	2000 devices / km2	1million devices /km2	>10million devices/km2	Connection density
Coverage percent	< 70 %	80%	>99 %	Coverage percent	< 70 %	80%	>99 %	Coverage percent	< 70 %	80%	>99 %	Coverage percent
Positioning precision	Meters precision (50 m)	Meters precision (20 m)	Centimeter precision	Positioning precision	Meters precision (50 m)	Meters precision (20 m)	Centimeter precision	Positioning precision	Meters precision (50 m)	Meters precision (20 m)	Centimeter precision	Positioning precision
End-to-end reliability	99.90%	100.00%	100.00%	End-to-end reliability	99.90%	100.00%	100.00%	End-to-end reliability	99.90%	100.00%	100.00%	End-to-end reliability
Receiver sensitivity	Around -100dBm	Around -120dBm	<130dBm	Receiver sensitivity	Around -100dBm	Around -120dBm	<130dBm	Receiver sensitivity	Around -100dBm	Around -120dBm	<130dBm	Receiver sensitivity

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Mobility support	350 km/h	500 km/h	1000 km/h	Mobility support	350 km/h	500 km/h	1000 km/h	Mobility support	350 km/h	500 km/h	1000 km/h	Mobility support
Satellite integration	No	No	Fully	Satellite integration	No	No	Fully	Satellite integration	No	No	Fully	Satellite integration
AI No Partial Fully	No	Partial	Fully	AI No Partial Fully	No	Partial	Fully	AI No Partial Fully	No	Partial	Fully	AI No Partial Fully
Autonomous vehicle	No	Partial	Fully	Autonomous vehicle	No	Partial	Fully	Autonomous vehicle	No	Partial	Fully	Autonomous vehicle
Extended Reality	No	Partial	Fully	Extended Reality	No	Partial	Fully	Extended Reality	No	Partial	Fully	Extended Reality
Haptic Communation	No	Partial	Fully	Haptic Communation	No	Partial	Fully	Haptic Communation	No	Partial	Fully	Haptic Communation
THz communication	No	limited	Widely	THz communication	No	limited	Widely	THz communication	No	limited	Widely	THz communication
Service level	Video	VR, AR	Tactile	Service level	Video	VR, AR	Tactile	Service level	Video	VR, AR	Tactile	Service level
Architecture	MIMO	Massive MIMO	Intelligent surface	Architecture	MIMO	Massive MIMO	Intelligent surface	Architecture	MIMO	Massive MIMO	Intelligent surface	Architecture
Max. frequency	6 GHz	90 GHz	10 THz	Max. frequency	6 GHz	90 GHz	10 THz	Max. frequency	6 GHz	90 GHz	10 THz	Max. frequency
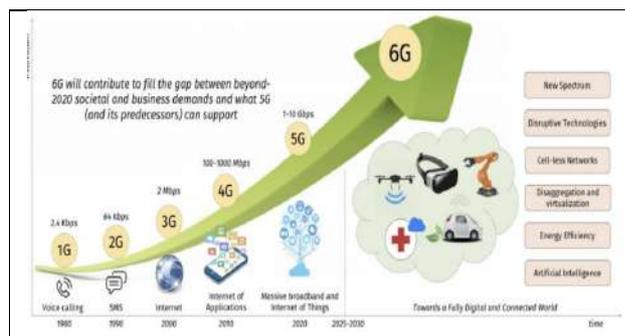
Figure 1. Three scenarios of 6G beyond 2030 [Karthik Kumar, 2019, Shimaa A. et la, 2022]	Figure 2. 6G architecture design goals {G. Kunzmann, 2022}
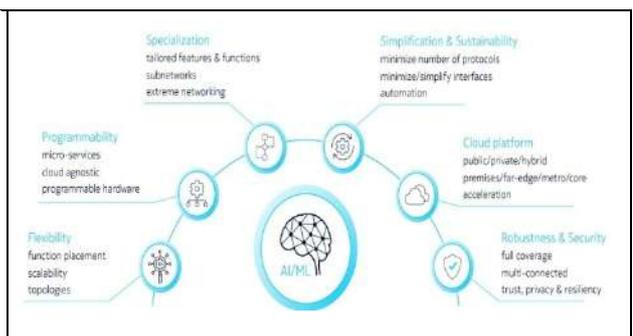
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Figure 3. End-to-end 6G architecture view [G. Kunzmann, 2022]	**Figure 4. 6G architecture**

REVIEW ARTICLE
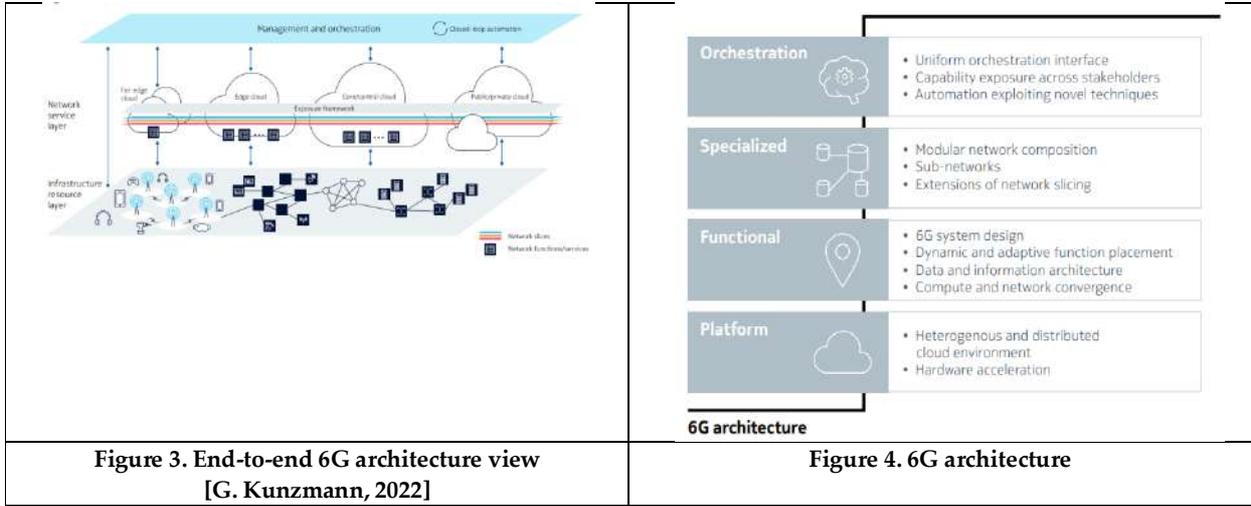
Secure Transaction System using Face Recognition: A Review

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ABSTRACT

In recent years, the e-commerce market has experienced remarkable expansion, with the security of personal and financial information being a key factor in its popularity. Ensuring the safety of customer data is essential to maintain trust in online transactions. This paper highlights the importance of securing data and building customer trust, particularly when transferring money through online transactions. One technology that has emerged in recent years is facial recognition, which uses digital images to automatically identify a person's information. Facial recognition technology, commonly employed in security systems and airports, is designed to match facial images from various perspectives in order to identify individuals and deter fraudulent activities. This cutting-edge tool plays a crucial role in preventing fraud and enhancing crime control. By capturing and storing facial images, it enables future identification and investigation. Operating on the basis of distinct facial characteristics like cheek curves, eyes, nostrils, and other unique features, this technology remains effective even in environments with limited lighting conditions, effectively combating identity theft.

Keywords: Security, Face recognition, Mobile Banking, Online Transaction, Authentication.

INTRODUCTION

Security is a critical factor in the digital age, especially when it comes to online transactions. One way to enhance security is through the use of OTP (One-Time Password) verification or facial recognition. OTP verification is a process where a unique password is generated for each transaction, which is sent to the user's registered mobile number or email. The user then enters this OTP to complete the transaction, ensuring that only the authorized user can carry out the transaction. This method provides an extra layer of security as even if someone has access to the

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user's login credentials, they won't be able to complete the transaction without the OTP. Facial recognition, on the other hand, involves using the user's face as a means of verification. The facial features of the individual are captured. and compared to pre-registered image, and the transaction is approved only if there is a match. This method is secure and convenient as it eliminates the need for the user to remember passwords or enter OTPs. It sounds like the system you are proposing is using facial recognition as a form of biometric authentication to verify the identity of the user during transactions. This is one way to enhance security and reduce the risk of fraudulent transactions. However, it's worth noting that facial recognition technology is not foolproof and can sometimes fail to match a user's face, especially in certain lighting conditions or if the user has changed their appearance. In such cases, sending an OTP (one-time password) can provide an additional layer of security.

The use of biometric authentication, specifically face recognition, in the case of account takeover is a promising solution to reduce fraud. Through the process of capturing and validating a real-time image of the cardholder during a transaction, the system can ensure that the person using the account is the authorized user. Face recognition stands out among various biometric data authentication methods, including fingerprint, hand geometry, iris, and palm. It offers exceptional usability and enjoys widespread acceptance. Additionally, it can be implemented with existing hardware such as smart phones or cameras, making it a practical solution for many businesses and consumers. However, it's important to note that biometric authentication should not replace other security measures such as PINs, but rather be used in conjunction with them for added security. Also, it's important to ensure that the biometric data is stored securely and is not vulnerable to hacking or theft. To enhance security further, facial recognition technology can be used to verify the identity of the user. This technology uses biometric data to confirm the identity of the user, such as facial features, which are unique to each person. By using facial recognition technology, authorized users can easily and securely access their accounts without the need for a password.

Overall, it is important to use a combination of strong passwords and advanced security technologies, such as facial recognition, to prevent unauthorized access and protect sensitive information.

What is Face recognition

Facial recognition technology is becoming increasingly common in many different industries, including law enforcement, security, retail, and social media. The technology uses algorithms to analyze and By examining various facial attributes, including the interocular distance, nasal shape, and facial contours, a distinctive "facial signature" can be established for every person. This process involves comparing these features to differentiate individuals from one another. The application of facial recognition extends to a broad range of uses, encompassing not only security measures but also various other purposes and surveillance, access control, and identity verification. For example, some airports and border control checkpoints Utilize facial recognition technology for identity verification of travelers, while some retail stores use the technology to identify and track customers for marketing purposes. However, facial recognition technology is also controversial, as it raises concerns about privacy, accuracy, and bias. Some experts have raised concerns about the potential for facial recognition systems to be used for mass surveillance or to discriminate against certain groups of people. Additionally, Instances have occurred where technology has generated inaccurate outcomes, resulting in incorrect identifications and unjustifiable arrests.

REVIEW OF LITERATURE

Biometric face recognition filters with the option to be easily canceled

Biometric authentication systems Utilize distinct physical or behavioral attributes to authenticate the identities of individuals. Biometric templates are the digital representations of these characteristics and are stored in a database for future comparisons. However, one challenge with biometric templates is their revocability. In case of a security breach, it may be necessary to revoke a template to prevent further unauthorized access. Therefore, it is crucial to design biometric authentication systems that can produce revocable templates. In this article, we propose a new scheme for producing revocable biometric templates. We use minimum mean correlation energy (MMCE) filters,

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which are widely used in biometric authentication systems. MMCE filters are designed based on training images that are specific to an individual's biometric characteristics. However, using the original training images to construct the filter creates a problem of revocability since the images cannot be changed once they are stored in the database. Overall, our proposed scheme provides a solution for producing revocable biometric templates without compromising authentication performance. The incorporation of this enhancement has the potential to enhance the security of biometric authentication systems significantly, consequently fostering their wider acceptance and utilization across various applications.

Develop a predictive model for facial recognition

The "Associate-Predict" (AP) model you described is a promising approach to managing variations between parties in facial recognition. By using a complementary common identity dataset with multiple images for each identity, the model can account for intra specific variability in facial features, such as changes in pose, lighting, and expression. The AP model works by first identifying facial features and encoding them into a compact representation. Then, it uses a predictive association model to match faces based on their encoded features, rather than relying solely on visual appearance. This approach allows the model to more accurately measure the similarity between faces, even when they are in significantly different settings. Overall, the AP model is a novel solution to a challenging problem in facial recognition. It has the potential to improve the accuracy and reliability of facial recognition technology, while also addressing concerns around privacy and bias. However, further research and development are needed to fully evaluate its effectiveness and ensure that it is being used in an ethical and responsible manner.

Facial feature detection for facial authentication

The mentioned research introduces an algorithm that focuses on detecting facial features and automating the extraction of features for face authentication. The approach employed in the research combines multiple techniques for both region detection and feature extraction from facial images. By leveraging these methods, the algorithm aims to enhance the accuracy and efficiency of facial authentication processes. The paper also mentions the use of a feature vector dimensionality reduction method. This approach offers the potential to decrease the dimensionality of the extracted feature vectors, which can help reduce computational complexity and improve the efficiency of the face authentication system. Overall, the approach described in the paper provides a comprehensive framework for facial feature detection and authentication. By combining various techniques for region detection and feature extraction, the proposed approach can effectively identify and authenticate individuals based on their facial features.

Partial Face Recognition

The method being discussed is commonly known as an "alignment-free" approach, indicating that it doesn't depend on accurately aligning facial features like eyes, nose, and mouth for face recognition. Rather, the technique outlined in the research paper utilizes a descriptor of variable size to represent each face, essentially capturing a collection of key point descriptors. This approach aims to capture the distinctive and discriminative features of a face by automatically detecting a set of key points. By employing this technique, the algorithm seeks to extract relevant facial information that can contribute to accurate and reliable face recognition. Various methods, including the Scale-Invariant Feature Transform (SIFT), Speeded up Robust Features (SURF), and Oriented FAST and Rotated BRIEF (ORB), can be utilized to identify these crucial points. Once detected, each key point is associated with a descriptor, which is computed based on the surrounding image details. These descriptors are subsequently combined to create a comprehensive representation of the entire face. The size of the descriptor can vary, depending on the number of key points detected and their distribution across the face. To recognize a partial face, the same process is applied to the image patch containing the partial face, and the resulting descriptor is compared to the descriptors of the known faces in a database using a similarity measure such as Euclidean distance or cosine similarity. The advantage of this approach is that it can handle partial faces captured under different conditions and orientations without the need for precise alignment. However, it may not be as accurate as alignment-based methods for recognizing full faces, especially under challenging conditions such as low resolution or occlusion.

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Improving User Authentication for Online Credit Card Payments
This article presents a novel process that introduces face match verification to enhance the security of online payment systems. The proposed method aims to strengthen the authentication process by incorporating facial recognition technology. By utilizing face match verification, the system enhances the overall security and reduces the risk of fraudulent transactions in online payment systems. The proposed process involves the use of facial recognition technology to verify the identity of the user making the transaction. This technology compares the user's face with a stored reference image to determine whether they are the legitimate owner of the account. The simulation provides valuable insights and data that contribute to the overall assessment of the system's effectiveness. The simulation involves a series of test scenarios to assess the accuracy and efficiency of the face match verification process. The results of the simulation demonstrate that the proposed process can effectively improve the security of online payment systems. Overall, the article highlights the importance of implementing advanced security measures to safeguard user information during online transactions. The proposed process with face match verification is a promising solution that can help to prevent unauthorized access and fraudulent activity in online payment systems.

A Face Recognition System in Real-Time Utilizing the Enhanced Local Binary Patterns Histogram Algorithm
The Local Binary Patterns Histogram algorithm is a widely used method for face recognition. It works by extracting local features from an image, encoding those using binary patterns, and then using a histogram to represent the distribution of these patterns. However, the LBPH algorithm suffers from decreased recognition rates when faced with variations in lighting, expression, and pose. To address these issues, a modified version of the LBPH algorithm called Median-based LBPH (MLBPH) has been proposed. In this method, instead of using the gray value of a pixel directly, the gray value is replaced by the median value of its surrounding pixels. This helps to reduce the effects of noise and other variations in the image. After the pixel values have been replaced by their median values, the image is divided into sub-blocks, and a statistical histogram is created for each block. These histograms are then combined to form a dictionary of MLBPH objects. When faced with a test image, the MLBPH algorithm extracts features from the image in the same way, and then compares the resulting feature vector to the MLBPH dictionary to find the closest match. Overall, the MLBPH algorithm is an improvement over the original LBPH algorithm, as It exhibits greater resilience towards changes in lighting conditions, facial expressions, and body positions. However, like any face recognition algorithm, it is not perfect and may still face challenges when dealing with highly variable images.

Exploring Deep Learning for Face Recognition Research
Deep learning models have consistently demonstrated exceptional performance in the field of face recognition, setting new benchmarks in accuracy and efficiency. The deep neural networks used in face recognition can learn hierarchical representations of facial features, which can be used to identify and verify individuals with high accuracy. There are various techniques and methods used in deep learning for face recognition, This line mentions three types of neural networks: convolutional neural networks (CNNs), recurrent neural networks (RNNs), and deep belief networks (DBNs). These models are trained on large datasets of labeled facial images and can learn to recognize and distinguish between different individuals. The applications of deep learning in face recognition are vast, ranging from security and surveillance to user authentication in mobile devices and social media platforms. The technology is also being used in healthcare for medical imaging analysis and in the entertainment industry for facial recognition-based special effects.

Review of Face Recognition Techniques
Research in the field of face recognition has been conducted from different perspectives, such as computer vision, machine learning, and pattern recognition. The development of face recognition technology has gone through several stages, including face detection, face alignment, feature extraction, and matching. Each of these stages involves different techniques and algorithms, and the development of these techniques has led to the improvement of face recognition accuracy. The evaluation of face recognition systems involves various criteria, such as accuracy, speed, and robustness. To evaluate the performance of face recognition algorithms, researchers use different face recognition databases, such as LFW, CFP, and IJB-A. The development of face recognition technology has led to significant progress in the field of biometrics. The technology has become an essential tool in various fields, and

ongoing research is focused on improving its accuracy, speed, and reliability. The use of general evaluation criteria and databases has allowed researchers to compare and evaluate different face recognition systems and techniques.

GPU-accelerated LBPH Algorithm for Frontal and Side Profile Face Recognition

LBPH algorithm is a popular method for facial recognition and can be implemented on different hardware platforms. The use of GPU for LBPH algorithm can significantly improve the performance of the system. In this paper, the LBPH algorithm is implemented on GPU for front and side face recognition. In this paper, the performance of the LBPH algorithm on CPU and GPU is compared. The experimental results show that the GPU implementation of the LBPH algorithm is significantly faster than the CPU implementation. The use of GPU reduces the execution time of the algorithm, making it suitable for real-time applications.

Digital Image Processing for Face Detection and Recognition System

Facial recognition systems have become an important technology in many industries, including security, law enforcement, and social media. As you mentioned, there are two main techniques used in facial recognition: Eigen face and Fisher face. The Eigen face method involves using principal component analysis to reduce the dimensionality of facial images, representing them as a linear combination of eigen faces, which are essentially statistical representations of the variations in a set of training images. The Fisher face method, on the other hand, uses Fisher's linear discriminant analysis to find a linear combination of facial features that best discriminates between different classes of faces. Digital image processing plays a critical role in developing facial recognition systems, as it involves preprocessing and enhancing images to improve the accuracy and robustness of the recognition algorithms. Techniques such as image normalization, filtering, and segmentation are commonly used in facial recognition systems to improve the quality of facial images and reduce the impact of variations in lighting, pose, and facial expression. However, facial recognition technology also raises concerns about privacy and ethical issues, particularly in the context of surveillance and law enforcement. As such, it is important to consider these issues and implement appropriate safeguards and regulations to ensure that facial recognition technology is used ethically and responsibly.

Study on Face Recognition Techniques

In the past few years, the popularity of facial recognition systems has soared due to their ability to provide a convenient and secure means of identifying individuals across various settings. These systems use biometric data, such as facial features, to identify individuals and grant access to certain areas or services. In order to develop a precise and efficient facial recognition system, it is crucial to utilize a variety of techniques and technologies. Facial recognition begins with the initial stage of face detection, which entails locating and identifying faces within an image or video. This process usually involves a combination of skin probabilistic image search and skin segmentation techniques. Skin probabilistic image search focuses on identifying areas in the image with skin-like tones, while skin segmentation employs algorithms to separate the skin regions from the non-skin regions. Once a face is detected, additional steps are taken to extract distinctive features for recognition. This typically involves morphometric operations to capture the facial boundary regions, allowing for analysis and identification of unique attributes such as the positioning of the eyes, nose, and mouth. Haar like feature detection can also be utilized to identify specific facial features like the eyes and mouth. Lastly, the detected face is subjected to face recognition technology to improve the accuracy of individual identification. This is accomplished by employing a combination of classifiers, such as neural networks, support vector machines, and decision trees. These classifiers assess the extracted facial features and compare them to a database of known faces, enabling the determination of the individual's identity.

Implementing a Face Recognition System in Real-Time

It is true that facial recognition technology has become increasingly important in a wide range of applications, including security, law enforcement, and user verification. Your proposed algorithm could potentially improve the efficiency and accuracy of facial recognition systems. PCA and LDA are two commonly used techniques in facial recognition. PCA reduces the dimensionality of the face image data by transforming the original images into a set of

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eigen faces. LDA, on the other hand, finds a linear combination of the original features that maximizes the class separation between different individuals. By combining the strengths of these two techniques, your algorithm may be able to achieve better recognition rates than either technique alone. Additionally, implementing the facial recognition system on an embedded system like Raspberry Pi 3 can make it more accessible and easier to deploy in real-world applications. However, it is important to note that facial recognition technology has also been subject to criticism and controversy, particularly in terms of privacy and potential biases in the data used to train the algorithms. It is important to carefully consider and address these concerns when developing and implementing facial recognition systems.

Rapid and Optimal Execution of Convolutional Neural Networks

The authors of the paper identified a key challenge faced by deep neural networks for image recognition tasks - the trade-off between depth and width. While increasing the depth of a network can lead to better accuracy, it also increases the number of parameters and computational complexity, making it more difficult to train and slower to evaluate. On the other hand, increasing the width of a network can improve accuracy but also increases the memory requirements and computational cost. In addition, the authors introduced other techniques to reduce the computational cost of the network, such as using 1x1 convolutions for dimensionality reduction and introducing auxiliary classifiers to encourage the network to learn more discriminative features. Overall, the Inception architecture proposed in this paper achieved state-of-the-art performance on the ILSVRC14 dataset while being more computationally efficient than previous approaches.

Detection of Credit Card Fraud Using Transaction Behavior

According to the paper, multiple classifiers were assessed in the process of model creation. The results indicate that the Random Tree and J48 classifiers achieved the most accurate outcomes, with accuracy values of 94.32% and 93.50% respectively. The accuracy of a detection model holds significance as it directly influences the model's ability to identify irregular transactions effectively. Upon further examination, it was observed that J48 exhibited a superior comprehension of transaction log data. This discovery emphasizes the significance of comprehending the data under analysis while constructing a detection model. Overall,the paper's recommendation to have a detection model in place as a fallback in case of EMV chip card technology failure is a wise one. It is important to have measures in place to detect anomalous transactions, as they can be indicative of fraudulent activity. The use of classifiers such as Random Tree and J48 can aid in the detection of anomalous transactions, with J48 being a better choice for understanding processing log data.

METHODOLOGY

Module 1: Dataset Creator

In this module, our objective is to create a comprehensive dataset that incorporates the user's photos along with the corresponding data they have provided. In order to achieve this, we will make use of different libraries. These include cv2, which is utilized for computer vision tasks, numpy for efficient handling of image arrays, and sqlite3 for creating the database dataset. The user's photographs will be stored in an array format to maintain the arrangement of pixels within a structured array. Furthermore, the relevant information, such as the user's ID and name, will be incorporated into the name of the stored image, thereby establishing a connection between the user and the system during the initial usage. The module utilizes the cascade classifier function from the cv2 library to store the user's photos using the Haar cascade algorithm. This module captures images using a camera as input and saves them in a grayscale format compatible with LBPH. The algorithm performs the necessary operations. Upon activation of the module, users will be prompted to input their name and ID number. The module incorporates the cv2 function to capture camera input and generate a block that utilizes the Harr Cascade Algorithm to identify facial features. A block is triggered whenever a face is detected, and a grayscale border is subsequently applied to the face, which is then saved in the database. At present, the code within this module determines the number of photos to be stored, with the current setting being 51.

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Module 2: Trainer

During this lesson, we will undergo training on the dataset created in the preceding module and export the resulting trained data as a.yml file. This particular module relies on several libraries, namely cv2 for image processing, os for accessing file paths, and numpy for image pixel manipulation and classification in array form. Another library utilized in this module is the Python Imaging Library. To facilitate image recognition, the module implements a local binary pattern histogram. This module utilizes the LBPH algorithm to train the images in the dataset by comparing their light and dark contrast. The primary objective is to establish boundaries for each object present in the image, achieved by initially assigning labels to distinct sets of pixels.

Module 3: Detector

The module serves as the primary component through which the client can obtain desired output. To harness real-time functionality within this module, the cv2 library is utilized. Additionally, the numpy library is employed to manipulate both the pixel array of the image and the camera's input stream, specifically in the context of regional binary operations. Moreover, the module incorporates the utilization of pattern histograms to facilitate the matching process of faces within the input image. The basic idea behind LBP is to describe the local structure of an image by comparing each pixel to its neighboring pixels. Specifically, LBP calculates a binary code for each pixel in an image based on the relative values of its neighboring pixels. This binary code is then used as a feature descriptor to represent the texture of the image. The LBP operator works by comparing the gray level intensity of each pixel with its surrounding neighbors. For each pixel, a binary pattern is generated based on the comparisons of the intensity value of the central pixel to its neighbors. The pattern is then converted to decimal form to produce the LBP value for that pixel. The LBP values for all the pixels in an image are then concatenated to form a feature vector. LBP has been used in a wide range of applications, such as face recognition, texture classification, object detection, and even medical imaging. It is a computationally efficient feature descriptor and is robust to illumination changes and noise. However, it may not be as effective in representing more complex textures or patterns. In the first module yields two outputs: the customer id, which the customer inputted in previous, and a confidence value. The confidence value is determined by comparing the real-time input image of the person to the machine's trained image, indicating the accuracy of the machine's prediction. To ensure secure and reliable payment processing, the One-Time Password (OTP) is delivered to the email address provided during registration of the recognized individual. The transaction can only be successfully completed after entering the OTP, which is verified using a PIN, adding an extra layer of security.

Architecture of face recognition system

Many techniques are used in face recognition some are given blow:

LAPH Algorithm

The LBPH approach involves dividing the visual frame into a grid-like arrangement, with each pixel representing a grid cell. In order to capture the image's contrast, the algorithm examines the pixel and its surrounding pixels, forming virtual lines. A circular boundary is placed around the central pixel, and eight neighboring pixels are chosen. If the central pixel's value exceeds that of its neighbors, it is assigned a '0'; otherwise, a '1' is assigned. This procedure generates virtual lines across the image, effectively capturing the fluctuations in light and dark contrasts.

Neural Network

A neural network can be described as a network or circuit composed of biological neurons in the field of biology. In modern times, the term "neural network" can also encompass an artificial neural network comprising artificial neurons or nodes. Therefore, a neural network can encompass both a biological neural network composed of biological neurons and an artificial neural network utilized for addressing artificial intelligence (AI) challenges.

Cascade Algorithm

Instead of relying on virtual lines, the Cascade Algorithm employs wavelets to process images. Prior to applying this technique to a photograph, the image must be converted to grayscale. By sampling light and dark hues from various

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images and blending them, a wave pattern is generated. This Haar wavelet pattern is then employed to analyze facial structure and aid in recognition.

Existing System
A typical multi-factor authentication system typically starts by asking the user to enter their login details, including their username and password. Afterward, an extra verification step is added, such as receiving an SMS message on the user's registered phone, which serves as something they possess. By incorporating photo recognition into the authentication process, an additional layer of security can be introduced without excessively burdening authorized users during the login process. Many banks utilize photo recognition as part of their multi-factor authentication system, allowing customers to securely access their accounts and authorize financial transactions. Moreover, photo recognition authentication proves to be an effective safeguard against phishing attempts, where deceptive websites attempt to replicate the appearance of genuine banking platforms.

Data Flow Diagram
A data flow diagram (DFD) is a visual depiction illustrating the movement of data within an information system. It presents a broad perspective of the system's data flow while avoiding excessive intricacies. With a DFD, one can easily visualize the movement of data between different processes within the system. This enables stakeholders to gain a better understanding of the system's information flow and identify any areas that may require improvement or optimization.

The system's flow follows these steps:
1. The user enters the preferred payment amount and verifies it.
2. The system conducts facial authentication by comparing the provided image with pre-existing datasets.
3. Upon successful facial verification, the payment is successfully executed.
4. In the event of facial verification failure, the system prompts the user to input a PIN code.
5. If the PIN code is verified, the payment is processed successfully.
   If the PIN code verification fails, the payment is declined. This process ensures the security and authorization of payments by employing facial recognition as the primary method and a secondary verification approach to mitigate the possibility of unauthorized transactions.

RESULT

Learning Rate (0.0001)
In the graph mentioned, the x-axis represents the images, which could refer to different samples or instances in a dataset. The y-axis represents the IOU (Intersection over Union), which is a metric commonly used to evaluate the accuracy of object detection or segmentation algorithms. The IOU measures the overlap between the predicted and ground truth regions, providing a measure of how well the algorithm performs in capturing the objects of interest. The graph is likely used to visualize the relationship between the images and their corresponding IOU values, which can help analyze the performance of a model or algorithm in terms of object detection or segmentation accuracy. In the blow graph y-axis stand for recall and x-axis stand for image. Based on the conducted experiments, it was found that a learning rate of 0.0001 resulted in the detection of objects. However, it is noted that this learning rate led to lower accuracy in terms of classification. A lower learning rate like 0.0001 generally means smaller weight and bias adjustments during the training process. While this may allow the model to detect objects, it could lead to slower convergence and potentially lower classification accuracy.

Iterations: 800000
In the blow graph y-axis stand for recall and x-axis stand for image. In the blow graph y-axis stand for recall and x-axis stand for image. Based on the conducted experiments, it was found that the optimal value for the training parameter "Iterations" was 800,000. When training the network for fewer iterations, fewer bounding boxes were

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predicted, and the accuracy was lower. Training iterations refer to the number of times the model goes through the training data during the training process. It allows the model to update its weights and biases, gradually improving its performance. In this case, training the network for 800,000 iterations led to improved performance in terms of both the number of predicted bounding boxes and their accuracy. However, it's important to note that the optimal number of iterations may vary depending on the specific dataset, model architecture, and problem being addressed.

CONCLUSION

The objective of the research is to improve the ease of payment by leveraging the OpenCV module in the Python programming language. It involves creating a database of user face images, along with their account details and registered phone number. The system employs the LBPH algorithm and Haar cascade classifier for training purposes within the project. Once the user's face is recognized by the machine, a unique OTP (One-Time Password) is generated and sent to the registered email address during the payment process. To provide additional security, the OTP is further reinforced with pin verification. This combination of facial recognition, OTP, and pin verification ensures a robust and secure payment experience.

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Module 1: Dataset Creator	Module 2: Trainer
Module 3: Detector	**Fig. 1.LAPH Algorithm:**

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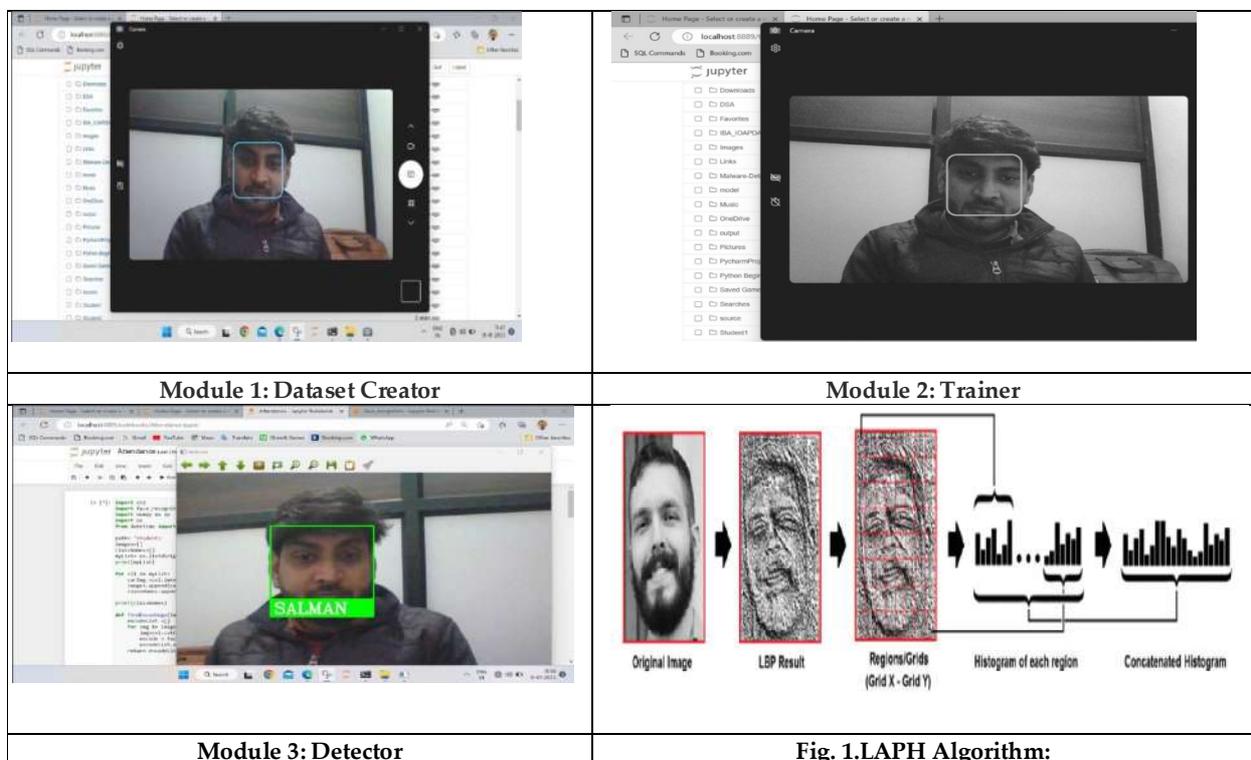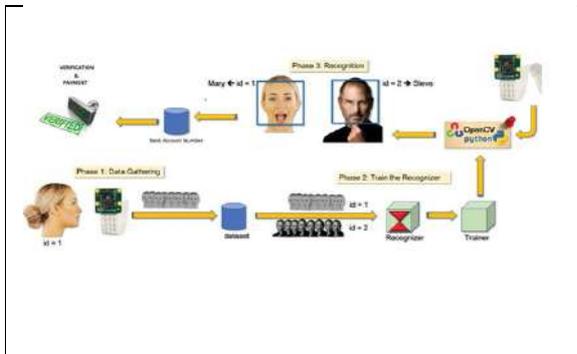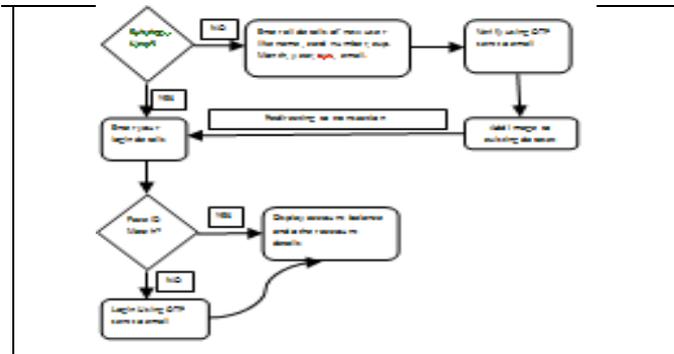
Fig. 2. Cascade Algorithm	**Fig. 3. Proposed System**
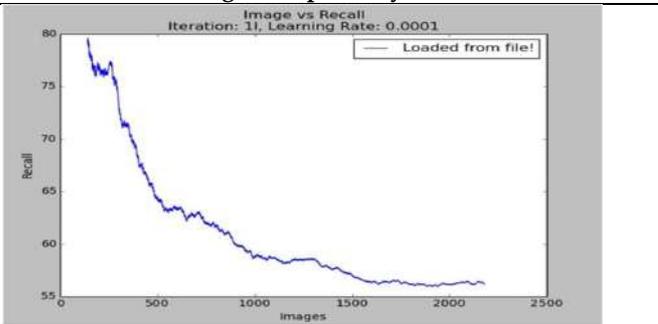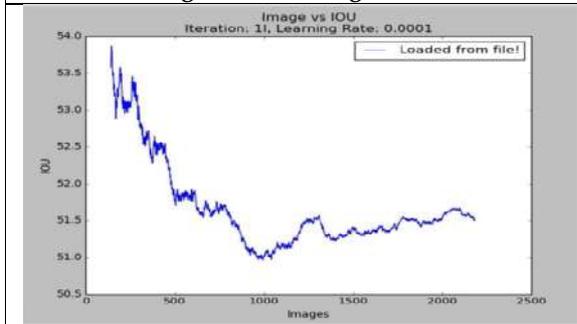
Fig. 4. Learning Rate (0.0001)
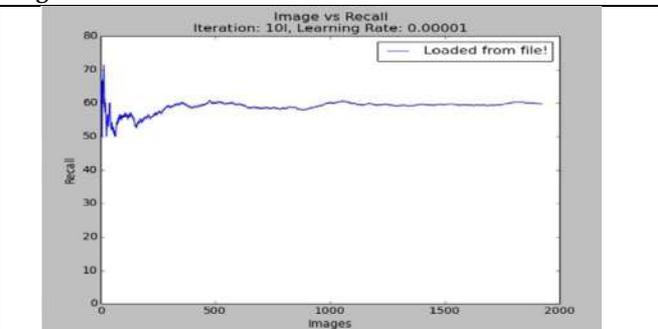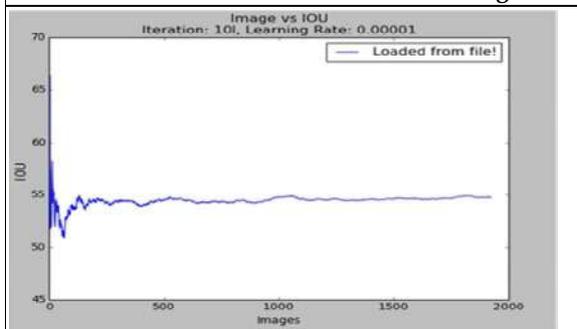
Fig. 5. Iterations: 800000

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REVIEW ARTICLE

A Review on Biodegradable Cellulose Based Bio films as a Viable Packaging Material in Pharmaceutical and Food Industry

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ABSTRACT

Biodegradable packaging materials have gained significant attention in recent years due to the growing concerns about plastic pollution and environmental sustainability. This review article explores the potential of cellulose-based bio films as a sustainable alternative for packaging in the pharmaceutical and food industries. Cellulose, a renewable and biodegradable polymer, offers several advantages such as biocompatibility, mechanical strength, and barrier properties. This review evaluates the current state of cellulose-based bio films in packaging applications and discusses their potential benefits and challenges.

Keywords: Biodegradable, biocompatibility, cellulose

INTRODUCTION

Plastic packaging has been widely used in the pharmaceutical and food industries due to its convenience and durability. However, the environmental consequences of plastic waste have raised concerns, prompting the exploration of alternative packaging materials. Biodegradable cellulose-based biofilms have emerged as a promising option due to their renewable nature, biocompatibility, and potential to reduce the environmental impact of packaging. The use of plastic for packaging has grown extensively in recent years. Inert and non-biodegradable plastic materials represent ~30% of municipal solid waste. In this context, biodegradable films can be a source of saving of energy and an important issue for environmental protection [1]. Biodegradable polymers into three groups of (a) blends of synthetic polymers (i.e., polyethylene) with natural polymers, (b) bacterial polyesters

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(polyhydroxyalkanoates), and (c) natural polymers more or less modified (polysaccharides or proteins) [2]. Considering the low cost of raw material and the beneficial impact on the environment, the natural polymers became the subject of intensive studies for the development of biodegradable films [3].

Introduction to Cellulose Biofilms
Cellulose biofilms represent a promising class of biodegradable materials with diverse applications, ranging from packaging to biomedical devices. These biofilms are primarily composed of cellulose, a linear polysaccharide consisting of repeating glucose units linked together by β-1,4 glycosidic bonds. Cellulose is the most abundant biopolymer on Earth and is mainly found in plant cell walls, making it a renewable and sustainable resource [4].

Cellulose as a Renewable Polymer
One of the key advantages of cellulose-based bio films is the renewability of the raw material. Cellulose can be sourced from various plant-based feed stocks such as wood pulp, cotton, hemp, and agricultural residues [5]. This abundance and renewability make cellulose a viable alternative to petroleum-based plastics, addressing concerns related to resource depletion and environmental sustainability.

Biocompatibility and Safety
Cellulose is inherently biocompatible and safe for contact with biological systems, including human tissues [6]. This property is of particular importance when considering applications in the pharmaceutical and biomedical fields, where direct contact with the human body or sensitive drug compounds is common. Cellulose-based bio films have been extensively studied for wound dressings, tissue engineering scaffolds, and drug delivery systems [7].

Mechanical Strength and Barrier Properties
Cellulose bio films possess remarkable mechanical strength, which can be further enhanced through processing and modification techniques [8]. These bio films also exhibit excellent barrier properties against oxygen, moisture, and UV radiation, making them suitable for various packaging applications [9]. In the food industry, cellulose-based bio films can extend the shelf life of products by acting as an effective barrier against external factors that contribute to spoilage and degradation.

Environmental Benefits
Perhaps the most compelling feature of cellulose bio films is their biodegradability [10]. Unlike conventional plastics that persist in the environment for centuries, cellulose-based materials can be broken down by microorganisms into harmless compounds, reducing long-term ecological impact and mitigating plastic pollution issues.

Versatility in Processing and Functionalization
Cellulose bio films are highly versatile materials that can be processed into various forms, including films, coatings, and composites [11]. Additionally, cellulose's surface can be modified to introduce specific functionalities, such as antimicrobial properties or controlled drug release, expanding its range of applications in both the pharmaceutical and food industries [12].

Biomasses that can be used for Cellulose Extraction
Cellulose, a natural polymer composed of glucose units, is a key component of plant cell walls. It can be extracted from a wide range of biomasses, making it a versatile and sustainable raw material for various applications. Here, we'll discuss some of the biomasses commonly used for cellulose extraction, along with relevant references in Vancouver formatting

Wood Biomass
Wood is one of the most abundant and widely used sources of cellulose. Both hardwoods (e.g., oak, birch) and softwoods (e.g., pine, spruce) contain significant amounts of cellulose [13].

Cotton Linters
Cotton linters are short cellulose fibers obtained from the cotton plant after ginning. They are primarily composed of cellulose and are used for various industrial applications, including papermaking [14].

Agricultural Residues
Various agricultural residues, such as rice straw, wheat straw, and sugarcane bag gasse, are rich sources of cellulose. These residues are often left unused and can be valorized through cellulose extraction [15].

Algae
Certain types of algae, such as green algae and brown algae, contain cellulose in their cell walls. Algae-derived cellulose has gained attention for its potential in sustainable bio products [16].

Bacterial Cellulose
Bacterial cellulose is produced by various bacterial strains, such as Aceto bacter and Komagataei bacter. It is a unique source of high-purity cellulose with applications in biotechnology [17].

Municipal Solid Waste (MSW)
Cellulose can also be extracted from paper and cardboard components of municipal solid waste. Recycling cellulose from MSW contributes to waste reduction [18]

Applications of Cellulose Biofilms in Pharmaceutical and Food Industry
Applications of Cellulose Bio films in Pharmaceutical Industry
Cellulose-based biofilms have gained significant attention in the pharmaceutical industry due to their biocompatibility, biodegradability, and potential for controlled drug delivery. These versatile materials find application in various aspects of pharmaceutical packaging and drug delivery systems.

Drug Delivery Systems
Cellulose-based bio films have been explored as promising materials for drug delivery systems. They can be tailored to control the release of pharmaceutical compounds, ensuring the sustained and controlled delivery of drugs to patients. By adjusting the composition and structure of cellulose bio films, researchers can achieve specific drug release profiles, making them suitable for a wide range of therapeutic applications [19].

Blister Packaging
In the pharmaceutical industry, blister packaging is commonly used to protect individual doses of medication. Cellulose-based blister packs have emerged as an eco-friendly alternative to traditional plastic blister packaging. These bio films provide a protective barrier for pharmaceutical products while being biodegradable and compostable, addressing sustainability concerns [20].

Edible Films for Oral Drug Administration
Cellulose-based bio films have also been investigated for their potential use in edible films for oral drug administration. These films can encapsulate pharmaceutical compounds, making them easier to administer, especially for pediatric and geriatric populations. They dissolve in the oral cavity, releasing the drug and eliminating the need for traditional tablets or capsules [21].

Wound Dressings
Cellulose bio films have been employed in the development of wound dressings for pharmaceutical applications. These bio films possess moisture-absorbing properties and can be designed to release pharmaceutical agents, promoting wound healing and reducing the risk of infection [22].

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Vaccine Stabilization

The stability of vaccines is crucial for their efficacy. Cellulose-based bio films have been explored as stabilizing agents for vaccine formulations. They can help protect the vaccine from degradation due to temperature fluctuations and moisture exposure, making them valuable in the storage and transportation of vaccines [23].

Drug-Coated Implants

Cellulose bio films can be coated with pharmaceutical compounds to create drug-coated implants. These implants provide controlled drug release over an extended period, making them suitable for localized drug delivery applications, such as implantable contraceptive devices and orthopedic implants [24].

Buccal Drug Delivery

In buccal drug delivery, cellulose-based bio films have been used to create mucoadhesive drug delivery systems. These systems adhere to the mucous membranes of the oral cavity, allowing for the controlled release of pharmaceutical compounds, providing an alternative to traditional oral delivery methods [25].

Taste-Masking in Pediatric Medications

Cellulose bio films can be employed to mask the taste of pharmaceutical formulations, particularly important for pediatric medications. By encapsulating the drug in a taste-masked cellulose-based bio film, it becomes more palatable and easier to administer to children [26].

Applications of Cellulose Bio films in Food Industry

The pharmaceutical industry has been actively exploring cellulose-based biofilms as a sustainable and versatile alternative for various packaging and drug delivery applications. The following sections discuss the key applications of cellulose bio films in pharmaceuticals.

Food Wraps

Cellulose-based bio films are increasingly being used as an eco-friendly alternative to conventional plastic wraps. These bio films are particularly advantageous for wrapping fruits, vegetables, cheeses, and baked goods. They provide excellent moisture resistance, maintaining the freshness of the food products, and helping to extend their shelf life. Cellulose food wraps are also compostable, reducing waste and environmental pollution [27].

Edible Packaging

Edible packaging represents an innovative application of cellulose bio films in the food industry. These bio films can be used to create edible coatings or casings for various food items, such as sausages, candies, and even beverages. They offer a unique combination of biodegradability and consumer convenience. Edible packaging reduces the need for additional packaging materials and enhances the overall eating experience [28].

Barrier Films

Cellulose-based bio films can be engineered to function as effective barrier materials, providing protection against moisture, oxygen, and other contaminants. In food packaging, these barrier films are crucial for preserving the quality and safety of perishable products. They are commonly used for packaging snacks, cereals, and dehydrated foods. The biocompatibility of cellulose bio films ensures that they do not compromise the sensory properties or safety of the enclosed food items [29].

Fresh Produce Packaging

Cellulose-based bio films are employed in the packaging of fresh produce, such as salads, herbs, and berries. Their moisture-resistant properties help maintain the appropriate humidity levels within the packaging, reducing wilting and extending the shelf life of the produce. These bio films are especially useful for organic and natural food products, where sustainable packaging is a significant selling point [30].

Dessert and Pastry Packaging
In the dessert and pastry industry, cellulose bio films are used for packaging delicate and perishable items like cakes, pastries, and chocolates. They provide an excellent moisture barrier, preventing the items from becoming soggy or losing their crispness. Additionally, cellulose bio films can be printed with food-safe ink for branding and product information [31].

Dairy Product Packaging
Cellulose bio films are used for packaging dairy products such as yogurt and cheese. They help maintain the freshness and flavor of these products while offering a sustainable alternative to traditional plastic containers. The biodegradable nature of cellulose bio films aligns with the environmentally conscious preferences of many consumers [32].

FUTURE PROSPECTS AND CHALLENGES
Future Prospects and Challenges: the future prospects of Cellulose Bio films in Pharmaceutical and Food Industry are discussed elaborately below

Sustainability and Environmental Benefits
Biodegradable cellulose-based bio films offer pharmaceutical companies an eco-friendly alternative to traditional packaging materials. As global sustainability concerns grow, the pharmaceutical industry is likely to increasingly adopt cellulose-based bio films to reduce its environmental footprint.

Extended Shelf-Life
Cellulose-based bio films can be engineered to provide excellent barrier properties against moisture, oxygen, and UV radiation. This can extend the shelf-life of pharmaceutical products, ensuring their efficacy over a longer period, which is a significant advantage in the industry [33].

Customizability and Functionalization
Researchers are exploring methods to customize cellulose-based bio films to meet specific pharmaceutical packaging needs. Functionalization with antimicrobial agents, desiccants, or indicators for temperature and humidity can enhance product stability and safety [34].

Drug Delivery Integration
Cellulose-based bio films can be designed not only as packaging but also as drug delivery carriers. This integrated approach may lead to innovative drug delivery systems, simplifying dosing regimens and improving patient compliance.

Printable Electronics and Smart Packaging
Incorporating printable electronics into cellulose-based bio films can enable smart packaging solutions. These can provide real-time information on product status, authenticity, and usage, enhancing pharmaceutical safety and traceability [35]
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Challenges of Biodegradable Cellulose-Based Bio films in Pharmaceutical Packaging
Regulatory Compliance
Meeting stringent pharmaceutical regulations and quality standards is a significant challenge. Pharmaceutical packaging materials must adhere to strict guidelines for safety, stability, and compatibility with drugs. Manufacturers will need to navigate regulatory hurdles to gain widespread acceptance.

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Scalability
While research shows promise, scaling up the production of cellulose-based bio films to meet the demands of the pharmaceutical industry remains a challenge. Large-scale production methods that maintain quality and consistency are needed [36].

Cost Considerations
At present, cellulose-based bio films may be more expensive to produce compared to conventional plastics. Pharmaceutical companies must weigh the environmental benefits against the potentially higher production costs.

Durability and Handling
 Ensuring that cellulose-based bio films can withstand the rigors of pharmaceutical handling and distribution, including resistance to tearing and puncturing, is vital.

Biodegradability in Controlled Environments
While biodegradability is an advantage, pharmaceutical products should ideally remain stable during their intended shelf-life. Balancing biodegradability with the need for long-term product integrity can be complex.

Consumer Acceptance
Pharmaceutical packaging materials must instill confidence in consumers regarding product safety and integrity. Ensuring that consumers understand the benefits of cellulose-based bio films is essential for their successful adoption [37].

CONCLUSIONS

In conclusion, biodegradable cellulose-based bio films hold great promise as sustainable and effective packaging materials in the pharmaceutical industry. However, addressing challenges related to regulatory compliance, scalability, cost-effectiveness, durability, and consumer acceptance will be critical for their widespread adoption. Continued research and innovation in this area are necessary to fully realize the potential of cellulose-based bio films in pharmaceutical packaging. Cellulose-based bio films hold significant promise as a sustainable packaging material in the pharmaceutical and food industries. Their renewable nature, biocompatibility, and strong barrier properties make them a viable alternative to traditional plastics. With ongoing research and innovation, cellulose-based bio films are poised to play a crucial role in reducing the environmental impact of packaging while ensuring product safety and quality.

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RESEARCH ARTICLE

A Study of Factors Affecting Work Life Balance of Women Teachers with Special Reference to Bangalore City

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ABSTRACT

Work life balance is satisfaction of one mind and someone current state of achieving their goal. It is depend on many factors such as living standard, needs, family situation, marital status etc. Work life balance of women working ladies is never stable as they have come across to different phases of life. Work life balance before and after marriage will be different. There are many factors which are affecting work life balance of working women. This paper is based on working women in education sector of Bangalore city. Now a days women and men are equal. Their wants, passion, mission, career is same. Women also have same importance of career what men are having. Both are earning equal amount of money to run families. There are several factors affecting work life balance of women working in education sectors specially in colleges, universities, and schools. All the factors are properly analysed in this paper. Work life balance is fluctuating with passage of time and age. During the starting years of career, there are more expectation and one person is not satisfied with working environment and salary. With passage of time, expectations of teachers will shift to job security, family preference with less salary.

Keywords: Career, Education, Expectations, Goal, Marital, Needs.

INTRODUCTION

Work-life balance for women working in the education sector can be both rewarding and challenging. Educators play a crucial role in shaping the future of society, but their dedication to their profession can sometimes lead to an imbalance between work and personal life. Prioritizing self-care and well-being are essential for women in the

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education sector. Engaging in activities that reduce stress and promote mental and physical health can help maintain a healthy balance. Educational institutions and policymakers can contribute to improving the work-life balance of women in the education sector by implementing policies that support flexible work arrangements, offering adequate leave policies, providing access to professional development opportunities, and creating a supportive and inclusive work environment. Ultimately, achieving a successful work-life balance requires a combination of individual efforts, organizational support, and societal recognition of the valuable contributions made by women educators. Teachers often invest significant emotional energy in their work, as they must support and empathize with students facing various challenges. Managing this emotional labour can be emotionally draining and impact their personal lives. Engaging with parents through parent-teacher conferences, school events, and extracurricular activities can take up valuable personal time. Staying updated with new teaching methods and participating in professional development activities is essential for educators. However, attending workshops and training sessions can further impact their work-life balance.

Objective of Study
- To know various factors affecting work life balance of women teachers
- To study whether nature of occupation affecting work life balance

RESEARCH METHODOLOGY

This paper is based on primary and secondary data. Secondary data is collected from various journal, articles, book. There was thorough study done from various published articles. Primary data is also collected by interacting with some women working in colleges and schools in Bangalore.

LITERATURE REVIEW

Work-life balance has emerged as a critical aspect of the well-being and job satisfaction of women teachers worldwide. In Bangalore city, a thriving educational hub in India, women teachers face unique challenges in managing their professional responsibilities while maintaining a fulfilling personal life. This literature review aims to study the factors that impact the work-life balance of women educators in Bangalore city, drawing insights from existing research and studies.

Workload and Time Demands
Numerous studies highlight the heavy workload and time constraints faced by women teachers in Bangalore. Balancing lesson planning, grading, administrative tasks, and classroom teaching often leads to extended work hours and reduced personal time (Poonam & Yadav, 2020; Roy & Joshi, 2019).

Emotional Labor and Burnout
The emotional labour involved in teaching can take a toll on women teachers' well-being. Studies reveal that women teacher in Bangalore experience higher emotional exhaustion and burnout due to their responsibilities in supporting students' emotional needs and maintaining a positive classroom environment (Chandrasekharan & Majeed, 2018; Natarajan & Jayashree, 2021).

Family and Caregiving Roles
Women teachers in Bangalore often face the challenge of balancing their professional roles with family and caregiving responsibilities. Research indicates that societal expectations and gender norms place additional pressure on women teachers to fulfill domestic duties, leading to a potential work-life conflict (Devaraj & Udupa, 2018; Janaki & Srinivasan, 2019).

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Workplace Policies and Flexibility
The availability of flexible work arrangements and family-friendly policies significantly influences work-life balance. Studies suggest that a lack of flexible working hours and limited access to maternity leave and childcare facilities contribute to work-life imbalance among women teachers in Bangalore (Kumari & Chaudhary, 2018; Verma & Srivastava, 2020).

Organizational Support and Work Culture
The supportiveness of the organizational culture and leadership plays a crucial role in women teachers' work-life balance. Research indicates that a positive work culture that values work-life integration and offers support for personal commitments can positively impact women teachers' job satisfaction and well-being (Shetty & Rao, 2022; Thomas & Rao, 2019).

Factors Affecting Work Life Balance of Women Teachers
The work-life balance of women teachers can be influenced by various factors, which can vary depending on individual circumstances, workplace environment, and societal norms.

Workload and Time Demands
The workload of teachers can be extensive, involving lesson planning, grading, preparing materials, and interacting with students and parents. The time demands of teaching can make it challenging for women to balance their professional responsibilities with personal commitments.

Emotional Labor
Teaching often involves emotional labor, as educators invest time and energy in understanding and supporting their students' needs. Managing this emotional labor can be emotionally draining and impact personal well-being.

Work Hours and Scheduling
Traditional school schedules may require teachers to work long hours during the day, leaving less time for personal activities and family obligations.

Administrative Responsibilities
In addition to teaching, women teachers may have administrative duties, such as attending meetings, participating in committees, or overseeing extracurricular activities, which can further extend their work hours.

Parental Expectations
Women teachers who are also mothers may face added pressure to balance their roles as educators and caregivers, leading to increased responsibilities in both areas.

Lack of Work-Life Integration
The demands of teaching can make it challenging for women to integrate their personal and professional lives seamlessly, leading to conflicts between work and family commitments.

Limited Professional Growth Opportunities
In some cases, limited opportunities for career advancement or professional growth may impact the motivation and work-life balance of women teachers.

Supportive Work Environment
The work-life balance of women teachers can be influenced by the support they receive from school administrators, colleagues, and the overall work culture. A supportive work environment can reduce stress and improve work-life integration.

Flexibility in Work Arrangements
part-time positions, job-sharing, or telecommuting options, can empower women teachers to manage their time effectively.

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Gender Stereotypes and Expectations
Societal expectations and gender stereotypes can influence the roles and responsibilities assigned to women teachers, affecting their work-life balance.

Personal Support System
The presence of a supportive partner, family, or social network can play a crucial role in helping women teachers manage their personal and professional commitments. Addressing these factors requires a multi-faceted approach involving supportive workplace policies, cultural changes, and societal attitudes towards women's roles in the education sector. By creating a more inclusive and flexible environment, women teachers can be & Regenerate equipped.

Government and Non-Government Women Teachers
Government Women Teachers
Employment
Government women teachers work in educational institutions that are funded and managed by the government. These institutions include public schools, colleges, universities, and government-run educational programs.
Job Security
Government teachers generally enjoy a higher level of job security due to their positions being governed by government regulations and policies. They often have permanent or long-term contracts and are protected from arbitrary dismissals.
Salary and Benefits
Government women teachers often receive standardized pay scales and benefits, which may include pension plans, health insurance, paid leave, and other social security benefits. Their salaries are typically determined based on government guidelines.
Working Conditions
Government schools and institutions usually follow fixed working hours and academic calendars. Teachers may have regular vacations and holidays according to the academic schedule.
Professional Development
Government teachers may have access to various professional development opportunities provided or sponsored by the government, which can enhance their skills and career growth.
Union Representation
Government teachers often have the option to join teachers' unions or associations that advocate for their rights, negotiate for better working conditions, and address their concerns collectively.

Non-Government Women Teachers:
Employment
Non-government women teachers work in private educational institutions or non-profit organizations. These institutions include private schools, colleges, universities, tutoring centres, and education-related NGOs.
Job Security
Non-government teachers may have a comparatively lower level of job security compared to government teachers. Their employment may be based on contractual agreements or contingent on the institution's financial stability.
Salary and Benefits
Salaries and benefits for non-government teachers can vary widely depending on the financial health and policies of the specific institution they work for. Some private institutions may offer competitive salaries, while others may struggle to provide adequate compensation.
Working Conditions
Non-government women teachers may experience more varied working conditions, ranging from flexible working hours in tutoring centres to fixed schedules in private schools or universities.

Strategies for Improving Women Work Life Balance

Improving work-life balance is important for enhancing overall well-being, reducing stress, and increasing productivity. Here are some effective strategies that can help individuals achieve a better work-life balance:

Set Priorities

Identify your most important personal and professional goals and prioritize them. Focus on activities and tasks that align with your values and contribute significantly to your well-being and success.

Learn to Say No

Avoid over committing yourself by learning to say no to additional work or social obligations when your schedule is already full. Prioritize your existing commitments before taking on new ones.

Time Management

Utilize effective time management techniques to make the most of your work hours. Plan your day, create to-do lists, and use tools such as calendars or productivity apps to stay organized.

Delegate Tasks

If possible, delegate tasks at work and at home to lighten your load.Delegating responsibilities can help you focus on essential tasks and reduce feelings of overwhelm.

Flexibility and Remote Work

If your job allows, explore opportunities for flexible working hours or remote work arrangements. Flexibility can give you more control over your schedule and improve work-life integration.

Take Breaks

Incorporate short breaks during work hours to rest and recharge. Stepping away from your desk and taking short walks can enhance productivity and reduce stress

CONCLUSION

In conclusion, work-life balance is a crucial aspect of the well-being and job satisfaction of women teachers in Bangalore city. Our research has identified several factors that significantly influence their work-life balance. Firstly, demanding workload and time constraints faced by women teachers contribute to work-life imbalance. Juggling teaching responsibilities, administrative duties, and personal commitments can lead to increased stress and burnout. Secondly, the emotional labour involved in teaching and the pressure to meet parental expectations can further impact work-life balance. Women teachers often invest significant emotional energy in understanding and supporting their students, which can be emotionally 5 Regenerate draining. Thirdly, the lack of flexible work arrangements and access to family-friendly policies in some educational institutions can hinder women teachers' ability to balance their professional and personal lives effectively. Moreover, gender stereotypes and societal expectations play a role in shaping women teachers' roles and responsibilities, often leading to additional caregiving duties at home.

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RESEARCH ARTICLE

Analyzing Dry Bean Data through Association Rules

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ABSTRACT

Data mining has evolved into an important and active area of research because of theoretical challenges and practical applications associated with the problem of discovering interesting and previously unknown knowledge from very large real-world databases. In this paper, generation of association rules for dry beans dataset is considered. Apriori algorithm is used for the generation of association rules. Generated association rules are analyzed to determine the significant attributes which are helpful to identify the variety of dry beans.

Keywords: Data Mining, Association Rules, Frequent Item sets, Apriori.

INTRODUCTION

Data mining, which is also referred to as Knowledge Discovery in Databases (KDD), means a process of nontrivial extraction of implicit, previously unknown and potentially useful information (such as knowledge rules, regularities) from data in databases. Discovering knowledge from data should therefore be seen as a process containing steps such as understanding the domain, preparing the data set, discovering patterns (data mining), post processing of discovered patterns and putting the results to use. Association rule mining is one of the most important and well researched techniques of data mining. It aims to extract interesting correlations, frequent patterns, associations or casual structures among sets of items in the transaction databases or other data repositories [7]. Given a collection of items and a set of records, each of which contain some number of items from the given collection, an association discovery function is an operation against this set of records which return affinities that exist among the collection of

items. These affinities can be expressed by rules such as "72% of the records that contain items A, B and C also contain items D and E". The specific percentage of occurrences (in the case 72) is called the confidence factor of the association. Also, in the association, A, B and C are said to be on an opposite side of the association to D and E. Association Discovery can involve any number of items on either side of the association. A typical application that can be built using association discovery is supermarket problem. The problem is to analyze customers' buying habits by finding associations between the different items that customers place in their shopping baskets. The discovery of such association rules can help the retailer to develop marketing strategies, by gaining insight into matters like "which items are most frequently purchased by customers". It also helps in inventory management, sale promotion strategies, etc. Clustering is the identification of classes (clusters) for a set of unclassified objects based on their attributes. The objects are so clustered that the intraclass similarities are maximized and the interclass similarities are minimized based on some criteria. Once the clusters are decided, the objects are labeled with their corresponding clusters, and common features of the objects in a cluster are summarized to form the class description [4]. For example, a set of new diseases can be grouped into several categories based on the similarities in their symptoms, and the common symptoms of the diseases in a category can be used to describe that group of diseases.

Statement of the Problem

Data set dry bean is taken from the UCI machine learning repository. It includes values of sixteen features used to classify dry beans into 7 classes (Seker, Barbunya, Bombay, Cali, Horoz, Sira, Dermason). The dataset contains 13611 samples out of which 2027 samples are of Seker, 1322 samples of Barbunya, 522 samples of Bombay, 1630 samples of Cali, 1928 samples of Horoz, 2636 samples of Sira and 3546 Dermason samples. The dry bean dataset consists of 17 fields and 13611 records. The attributes along with their minimum and maximum values are presented in Table 1 and Figure 1. Table 2 shows the attribute Area and its range of values. Table 3 shows the attribute class and its range of values. Data discretization refers to a method of converting a huge number of data values into smaller ones so that the evaluation and management of data become easy. After applying data discretization technique, numeric attribute values are converted into a finite set of intervals.

METHODOLOGY

Discovery of interesting association relationships among huge amounts of data will help in marketing, decision making, fraud detection and business management. Therefore, mining association rules from large datasets has been a focused topic in recent research into knowledge discovery in databases [1,2,3].

The following is the standard definition of association rules:

Let I = {$i_1, i_2, \ldots i_m$} be a set of attribute values, called items. Let D be a set of database transactions where each transaction T is a set of items such that $T \subseteq I$. An association rule is an implication of the form $A \Longrightarrow B$, where $A \subseteq I$, $B \subseteq I$, and $A \cap B = \phi$. A is called the antecedent of the rule, and B is the consequent of the rule. The rule $A \Longrightarrow B$ holds in the transaction set D with support sup and confidence conf, where sup($A \Longrightarrow B$)=P($A \cup B$), conf($A \Longrightarrow B$)=P(B/A)=sup($A \Longrightarrow B$)/sup(A). Sup(A) is the percentage of transactions in D that contain A. Rules that satisfy both a minimum support threshold (min_sup) and a minimum confidence threshold (min_conf) are called strong ones.

In this paper, Apriori algorithm is used for generation of association rules. Apriori is an algorithm for extracting association rules from data. It contains the search space for rules by discovering frequent itemsets and only examining rules that are made up of frequent itemsets. Apriori deals with items and itemsets that make up transactions. Items are flag-type conditions that indicate the presence or absence of a particular thing in a specific transaction. An itemset is a group of items which may or may not tend to co-occur within transactions. Apriori proceeds in two stages. Firstly, it identifies frequent itemsets in the data, and then it generates rules from the table of frequent itemsets.

The first step in Apriori is to identify frequent itemsets. A frequent itemset is defined as an itemset with support greater than or equal to the user-specified minimum support threshold s_{min}. The support of an itemset is the number of records in which the itemset is found divided by the total number of records.

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The algorithm begins by scanning the data and identifying the single-item itemsets (i.e., individual items, or itemsets of length 1 that satisfy this criterion. Any single item that does not satisfy the criterion is not to be considered further, because adding an infrequent item to an itemset will always result in an infrequent itemset.

Apriori then generates itemsets recursively using the following steps:

- Generates a candidate set of itemsets of length k (containing k items) by combining existing itemsets of length (k-1). For every possible pair of frequent itemsets p and q with length (k-1), it compares the first (k-2) items (in lexicographic order); if they are the same, and the last item in q is (lexicographically) greater than the last item in p, it adds the last item in q to the end of p to create a new candidate itemset with length k.
- Prunes the candidate set by checking every (k-1) length subset of each candidate itemset; all subsets must be frequent itemsets, or the candidate itemset is infrequent and is removed from further consideration.
- Calculates the support of each itemset in the candidate set, as support = N_i/N where N_i is the number of records that match the itemset and N is the number of records in the training data.
- Itemsets with support $\geq s_{min}$ are added to the list of frequent itemsets.
- If any frequent itemset of length k is found, and k is less than the user-specified maximum rule size k_{max}, it repeats the process to find frequent itemsets of length (k+1).

When all frequent itemsets have been identified, the algorithm extracts rules from the frequent itemsets. For each frequent itemset L with length k > 1, Apriori generates rules using the following steps:

- Calculates all subsets A of length (k-1) of the itemset such that all the fields in A are input fields and all the other fields in the itemset (those that are not in A) are output fields. Call the latter subset A^I. (In the first iteration this is just one field, but in later iterations it can be multiple fields).
- For each subset A, it calculates the evaluation measure (rule confidence by default) for the rule $A \Longrightarrow A^I$.
- If the evaluation measure is greater than user-specified threshold, it adds the rule to the rule table, and, iflength k of A is greater than 1, it tests all possible subsets of A with length (k-1).

RESULTS AND DISCUSSION

Apriori algorithm first identifies the frequent itemsets (with the given minimum support at 10%) for dry beans dataset. When all frequent itemsets have been identified, the algorithm extracts rules (with the given minimum confidence at 50%) from the generated frequent itemsets for the dry bean dataset. Some of the generated association rules by Apriori algorithm are as follows:

Rules for Dermason:

Rule 1 for Dermason (1374, 99%)
        If Equiv Diameter is in (-∞,202.056824]
        and Roundness is in (0.890472,0.940579]
        then Dermason

Rule 2 for Dermason (1373, 99%)
        If Equiv Diameter is in (-∞,202.056824]
        and Roundness is in (0.890472,0.940579]
        and Perimeter is in (-∞,670.7994]
        then Dermason

Rule 3 for Dermason (1241, 98%)
        If Roundness is in (0.890472,0.940579]
        And Shape Factor1 is in (0.007382,0.008149]
        then Dermason

Rule 4 for Dermason (1492, 98%)
        If Perimeter is in (-∞,670.7994]
        and Roundness is in (0.890472,0.940579]
        then Dermason

Rule 5 for Dermason (1243, 86%)

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If Solidity is in (0.987134, ∞)
and Shape Factor1 is in (0.007382,0.008149]
then Dermason
Rule 6 for Dermason (1265, 58%)
If Solidity is in (0.987134, ∞)
and Perimeter is in (670.7994,816.8628]
and Minor Axis Length is in (156.281238, 190.049822]
then Dermason

Rule 1 specifies that if Equiv Diameter is in (-∞,202.056824] and Roundness is in (0.890472,0.940579], then there is 99% chance that dry bean is of type Dermason and 1374 instances support this rule. Rule 2 specifies that if Equiv Diameter is in (-∞, 202.056824] and Roundness is in (0.890472,0.940579] and Perimeter is in (-∞, 670.7994], then there is 99% chance that dry bean is of type Dermason and 1373 instances support this rule. Rule 3 specifies that if Roundness is in (0.890472, 0.940579] and Shape Factor1 is in (0.007382,0.008149], then there is 98% chance that dry bean is of type Dermason and 1241 instances support this rule. Rule 4 specifies that if Perimeter is in (-∞,670.7994] and Roundness is in (0.890472,0.940579] then there is 98% chance that dry bean is of type Dermason and 1492 instances support this rule. Rule 5 specifies that if Solidity is in (0.987134, ∞) and Shape Factor1 is in (0.007382, 0.008149] then there is 86% chance that dry bean is of type Dermason and 1243 instances support this rule. Rule 6 specifies that if Solidity is in (0.987134, ∞) and Perimeter is in (670.7994,816.8628] and Minor Axis Length is in (156.281238, 190.049822] then there is 58% chance that dry bean is of type Dermason and 1265 instances support this rule.

From above association rules 1, 2, 3, 4 are important. So,

1. Equiv Diameter is in (-∞,202.056824] and Roundness is in (0.890472, 0.940579]
2. Equiv Diameter is in (-∞,202.056824] and Roundness is in (0.890472, 0.940579] and Perimeter is in (-∞,670.7994]
3. Roundness is in (0.890472, 0.940579] And Shape Factor1 is in (0.007382, 0.008149]
4. Perimeter is in (-∞, 670.7994] and Roundness is in (0.890472, 0.940579] are the combination of important attributes which indicates that the dry bean is of type Dermason.

Rules for Horoz
Rule 1 for Horoz (1335, 99%)
If Eccentricity is in (0.842176, +∞)
and Equiv Diameter is in (242.869883,283.682942]
then Horoz
Rule 2 for Horoz (1335, 99%)
If Area is in (43839.6,67259.2]
and Eccentricity is in (0.842176, +∞)
and Equiv Diameter is in (242.869883,283.682942]
then Horoz
Rule 3 for Horoz (1335, 99%)
If Eccentricity is in (0.842176, +∞)
and Convex Area is in (44941.7,69199.4]
and Equiv Diameter is in (242.869883,283.682942]
then Horoz
Rule 4 for Horoz (1234, 99%)
If Eccentricity is in (0.842176, +∞)
and Equiv Diameter is in (242.869883,283.682942]
and Shape Factor2 is in (0.000874,0.001184]
then Horoz
Rule 1 specifies that if Eccentricity is in (0.842176, +∞) and Equiv Diameter is in (242.869883, 283.682942] then there is 99% chance that dry bean is of type Horoz and 1335 instances support this rule. Rule 2 specifies that if Area is in

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(43839.6, 67259.2] and Eccentricity is in (0.842176, +∞) and Equiv Diameter is in (242.869883, 283.682942] then there is 99% chance that dry bean is of type Horoz and 1335 instances support this rule. Rule 3 specifies that if Eccentricity is in (0.842176, +∞) and Convex Area is in (44941.7,69199.4] and Equiv Diameter is in (242.869883, 283.682942] then there is 99% chance that dry bean is of type Horoz and 1335 instances support this rule. Rule 4 specifies that if Eccentricity is in (0.842176, +∞) and Equiv Diameter is in (242.869883, 283.682942] and Shape Factor2 is in (0.000874, 0.001184] then there is 99% chance that dry bean is of type Horoz and 1234 instances support this rule.

From above association rules 1, 2, 3, 4 are important. So,

1.Eccentricity is in (0.842176, +∞) and Equiv Diameter is in (242.869883, 283.682942]

2.Area is in (43839.6,67259.2] and Eccentricity is in (0.842176, +∞) and Equiv Diameter is in (242.869883, 283.682942]

3.Eccentricity is in (0.842176, +∞) and Convex Area is in (44941.7,69199.4] and Equiv Diameter is in (242.869883,283.682942]

4.Eccentricity is in (0.842176, +∞) and Equiv Diameter is in (242.869883,283.682942] and Shape Factor2 is in (0.000874,0.001184] are the combination of important attributes which indicates that the dry bean is of type Horoz.

Rules for Seker

Rule 1 for Seker (1248, 98%)

If Aspect Ratio is in (1.165411,1.3050955]

and Equiv Diameter is in (202.056824,242.869883]

and Shape Factor4 is in (0.994528, ∞)

then Seker

Rule 2 for Seker (1269, 95%)

If Aspect Ratio is in (1.165411,1.3050955]

and Solidity is in (0.987134, ∞) and Shape Factor4 is in (0.994528, ∞)

then Seker

Rule 3 for Seker (1277, 93%)

If Equi Diameter is in (202.056824,242.869883]

and Roundness is in (0.940579, ∞) and ShapeFactor4 is in (0.994528, ∞)

then Seker

Rule 4 for Seker (1581, 57%)

If Minor Axis Length is in (190.049822,223.818406]

and Solidity is in (0.987134, ∞) and Shape Factor4 is in (0.994528, ∞)

then Seker

Rule 1 specifies that if Aspect Ratio is in (1.165411,1.3050955] and Equiv Diameter is in (202.056824,242.869883] and Shape Factor4 is in (0.994528, ∞) then there is 98% chance that dry bean is of type Seker and 1248 instances support this rule. Rule 2 specifies that if Aspect Ratio is in (1.165411,1.3050955] and Solidity is in (0.987134, ∞) and Shape Factor4 is in (0.994528, ∞) then there is 95% chance that dry bean is of type Seker and 1269 instances support this rule. Rule 3 specifies that if Equi Diameter is in (202.056824, 242.869883] and Roundness is in (0.940579, ∞) and Shape Factor4 is in (0.994528, ∞) then there is 93% chance that dry bean is of type Seker and 1277 instances support this rule. Rule 4 specifies that if Minor Axis Length is in (190.049822, 223.818406] and Solidity is in (0.987134, ∞) and Shape Factor4 is in (0.994528, ∞) then there is 57% chance that dry bean is of type Seker and 1581 instances support this rule. From above association rules 1, 2, 3 are important. So,

1. Aspect Ratio is in (1.165411,1.3050955] and Equiv Diameter is in (202.056824, 242.869883] and Shape Factor4 is in (0.994528, ∞)

2.Aspect Ratio is in (1.165411,1.3050955] and Solidity is in (0.987134, ∞) and Shape Factor4 is in (0.994528, ∞)

3.Equiv Diameter is in (202.056824,242.869883] and Roundness is in (0.940579, ∞) and Shape Factor4 is in (0.994528, ∞) are the combination of important attributes which indicates that the dry bean is of type Seker.

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Rules for Sira
Rule 1 for Sira (1472, 68%)
> If Shape Factor2 is in (0.001494,0.001804]
> then Sira

Rule 2 for Sira (1299, 51%)
If Perimeter is in (670.7994, 816.8628] and Shape Factor1 is in (0.00615, 0.007382]
> then Sira

Rule 3 for Sira (1274, 51%)
If Perimeter is in (670.7994, 816.8628] and Equiv Diameter is in (202.056824, 242.869883] and Shape Factor1 is in (0.00615, 0.007382]
then Sira

Rule 1 specifies that if Shape Factor2 is in (0.001494,0.001804] then there is 68% chance that dry bean is of type Sira and 1472 instances support this rule. Rule 2 specifies that if Perimeter is in (670.7994,816.8628] and Shape Factor1 is in (0.00615,0.007382] then there is 51% chance that dry bean is of type Sira and 1299 instances support this rule. Rule 3 specifies that if Perimeter is in (670.7994,816.8628] and Equiv Diameter is in (202.056824, 242.869883] and Shape Factor1 is in (0.00615,0.007382] then there is 51% chance that dry bean is of type Sira and 1274 instances support this rule.

Rules for Cali
Rule 1 for Cali (1246,60%)
> If Area is in (67259.2,90678.8]
> then Cali

Rule 2 for Cali (1242, 57%)
> If Shape Factor1 is in (0.00508,0.005847]
> then Cali

Rule 3 for Cali (1239, 39%)
> If Shape Factor2 is in (0.000874,0.001184]
> then Cali

> Rule 4 for Cali (1433,34%)
> If Eccentricity is in (0.772929,0.842176]
> then Cali

Rule 1 specifies that if Area is in (67259.2,90678.8] then there is 60% chance that dry bean is of type Cali and 1246 instances support this rule. Rule 2 specifies that if Shape Factor1 is in (0.00508,0.005847] then there is 57% chance that dry bean is of type Cali and 1242 instances support this rule. Rule 3 specifies that if Shape Factor2 is in (0.000874, 0.001184] then there is 39% chance that dry bean is of type Cali and 1239 instances support this rule. Rule 4 specifies that if Eccentricity is in (0.772929, 0.842176] then there is 34% chance that dry bean is of type Cali and 1433 instances support this rule.

Rules for Barbunya
No rules were generated for the class Barbunya**.** So, there are no significant attributes which are helpful to identify Barbunya dry bean.

Rules for Bombay
No rules were generated for the class Bombay. So, there are no significant attributes which are helpful to identify Bombay dry beans. The number of strong rules generated by Apriori algorithm for different minimum confidences (with 10% minimum support) is presented in Table 4 and Figure 2.

CONCLUSION

Association rules for dry bean dataset are generated using algorithm Apriori. The rules are analyzed and some of the graphs are generated. Using generated rules, the combinations of significant attributes which are helpful to identify the variety of dry beans are identified.

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Table 1: Attributes and their values

Attributes	Minimum Value	Maximum Value
Area	20420	254616
Perimeter	524.736	1985.37
Major Axis Length	183.601	738.86
Minor Axis Length	122.513	460.198
Aspect Ratio	1.025	2.43
Eccentricity	0.219	0.911
Convex Area	20684	263261
Equiv Diameter	161.244	569.374
Extent	0.555	0.866
Solidity	0.919	0.995
Roundness	0.49	0.991
Compactness	0.641	0.987
Shape Factor1	0.003	0.01
Shape Factor2	0.001	0.004
Shape Factor3	0.41	0.975
Shape Factor4	0.948	1
Class	**Seker, Barbunya, Bombay, Cali, Horoz, Sira, Dermason**	

Table 2: Attribute Area and its range of values

Area	No of records
(-∞,438396]	6519
(43839.6,67259.2]	4358
(67259.2,90678.8]	2075

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(90678.8,114098.4]	134
(114098.4,137518]	26
(137518,160937.6]	41
(160937.6,184357.2]	207
(184357.2,207776.8]	113
(207776.8,231196.4]	31
(231196.4, ∞)	7

Table 3: Attribute class and its range of values

Class	Number of records
Seker	2027
Barbunya	1322
Bombay	522
Cali	1630
Horoz	1928
Sira	2636
Dermason	3546

Table 4: Experimental results with Dry bean data by Apriori

Minimum Confidence	Number of Strong Rules
30%	631
50%	491
70%	333
90%	58

Figure1: Graphical representation of class attribute and values	Figure 2: Number of Strong Rules obtained on Dry bean Dataset

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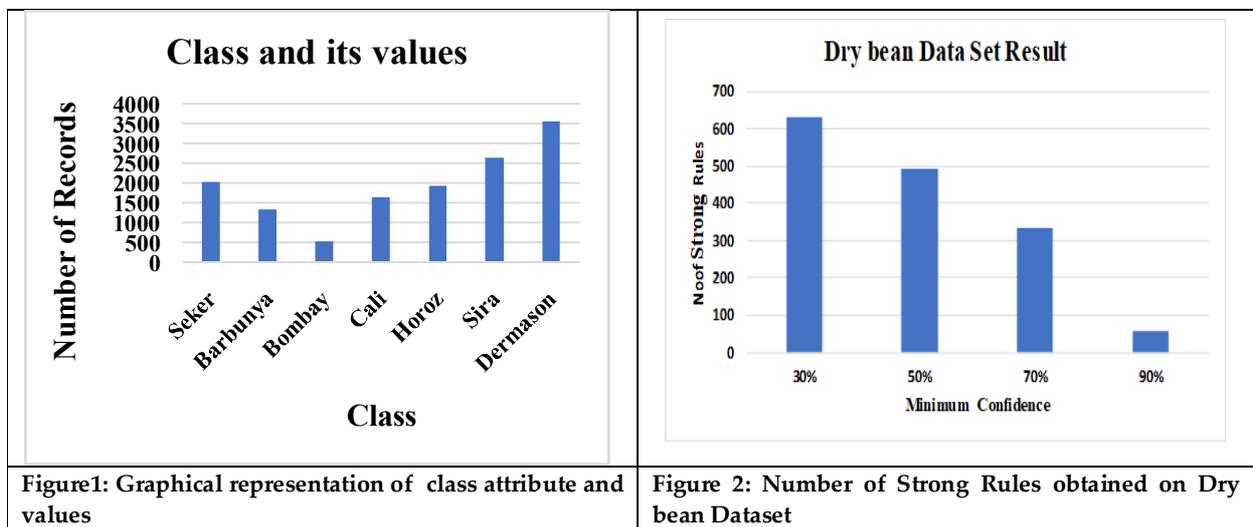
Efficacy of Yoga and Ayurvedic Diet on Waist Circumference and Low-Density Lipoprotein among Middle-Aged Women Diagnosed with Hypothyroidism

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ABSTRACT

Hypothyroidism concerns a significant proportion of women in India, which may culminate in an array of ailments like depression, abnormal heart rate, hypertension, excess weight, and elevated cholesterol. Hypothyroidism is on the rise in India, with a prevalence of 11%, which is significantly higher than the rates of 2.6% in the UK and 4.6% in the USA. The effectiveness of Yoga and Ayurvedic Diet has been demonstrated in addressing various health issues such as weight reduction, dyslipidaemia (specifically LDL cholesterol), depression, cardiovascular and respiratory problems. Additionally, these integrated approaches have shown promise in restoring the autonomic nervous system, offering valuable benefits in the management of issues associated with hypothyroidism. The study aimed to investigate if there were notable differences in specific physical variables, such as Waist Circumference (WC), and biochemical variables, like Low Density-Lipoprotein (LDL), in middle-aged women diagnosed with Hypothyroidism as a result of engaging in Yoga and following an Ayurvedic Diet. A randomized experimental study was carried out to assess the effectiveness of Yoga and an Ayurvedic Diet on Waist Circumference (WC) and Low Density-Lipoprotein (LDL) levels in middle-aged women aged between 35 and 60, who had been diagnosed with Hypothyroidism. Thirty middle-aged women were randomly divided into groups: 15 in both the Yoga and Ayurvedic Diet group, and the remaining 15 in the control group. Over eight weeks, the Experimental Group I (Yoga and Ayurvedic Diet) and Control Group II underwent pre-test and post-

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test evaluations having assessments centred on Waist Circumference (WC) and Low Density-Lipoprotein (LDL) ANCOVA (Analysis of Covariance) was employed to determine significant differences among the groups. The test of significance was set at a confidence level of 0.05. The study concluded that, as an integrated approach of, both Yoga and an Ayurvedic Diet, showed significant efficacy in lowering the Waist Circumference (WC) and the Low Density-Lipoprotein (LDL) among middle-aged women diagnosed with Hypothyroidism.

Keywords: Yoga & Ayurvedic Diet, Hypothyroidism, Waist Circumference (WC), Low Density-Lipoprotein (LDL), Middle-aged women.

INTRODUCTION

Hypothyroidism, where the thyroid gland is less active, causes a shortage of thyroid hormones, affecting crucial bodily functions like metabolism. If not addressed, it can lead to several health problems, including higher cholesterol levels that increase the risk of heart disease. Slower metabolism often results in weight gain. Furthermore, hypothyroidism can lower heart rate and raise blood pressure, possibly causing heart issues. It also influences fertility, mental health, and immunity, making individuals more prone to infections. The complex control of thyroid hormones is managed by the hypothalamic-pituitary-thyroid axis, a component of the neuroendocrine system tasked with preserving hormone equilibrium. Stress has the potential to impact this axis, altering processes such as metabolism, protein synthesis, and growth, which encompasses bone and neural development. Additionally, stress can influence the responsiveness to catecholamine hormones like adrenaline. In middle age, women often face increased stress levels, impacting their overall health, which is crucial for shaping later years' quality of life. As akey contributor to family and community health, it's pivotal to address their physical, psychological, social, and spiritual well-being. Proper evaluation and management of conditions like hypothyroidism are essential for their holistic health. Taking a proactive stance, women in this age group should seek medical attention for potential health issues and adopt a healthy lifestyle to fulfil their crucial roles. Prioritizing health during this stage positively influences well-being in later years, ensuring a fulfilling life.

Hypothyroidism exhibits varying prevalence worldwide, with India reporting 11%, in contrast to 2% in the UK and 4.6% in the USA(Bagcchi S., 2014).The highest rates are observed in individuals aged 36-50 (13.1%), while those aged 18-35 show lower prevalence (7.5%)(Unnikrishnan A et.al, 2011). Among individuals with diabetes, hypothyroidism rates range from 4.8% to 31.4%. Moreover, 9.5% of South Indians display elevated thyroid-peroxidase antibodies in the general population(Nair A *et.al,* 2018). Recognizing these global disparities and potential associations with diabetes is essential for effective management and promoting awareness of how the condition affects diverse populations. This study delves into the impact of Yoga & Ayurvedic Diet, an ancient Indian mind-body technique, on middle-aged women diagnosed with Hypothyroidism. The approach aims to stabilize and recondition the psycho-physiological makeup, influencing natural endocrinal homeostasis. Previous research has suggested positive effects of Yoga & Ayurvedic Diet on parameters such as waist circumference, body mass index (BMI), heart rate, and total cholesterol. This current study specifically focuses on investigating the influence of Yoga & Ayurvedic Diet on waist circumference and Low-Density Lipoprotein in middle-aged women with Hypothyroidism. Understanding the potential benefits of these practices in managing waist circumference and related health factors could contribute to enhanced well-being for this specific population.

Yoga is a holistic practice that encompasses both breath control (pranayama) and physical postures (asanas). It is a rich and ancient tradition with a profound presence in the world. Yoga, as an ancient Indian mind-body technique, is designed to bring stability and recondition the psycho-physiological makeup of individuals, which in turn can influence the body's natural endocrine balance. One notable effect of yoga is its association with increased levels of gamma-aminobutyric acid (GABA) in the brain. GABA is an inhibitory neurotransmitter that plays a role in reducing

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stress and promoting relaxation(Streeter CC et.al, 2007).Meditation, a key component of yoga, exerts its effects through various physiological pathways, primarily involving the endocrine system. This includes the regulation of the hypothalamic-pituitary-adrenal (HPA) axis, the hypothalamic-pituitary-thyroid (HPT) axis, and the renin-angiotensin-aldosterone system, as well as energy homeostasis. Research in the field of yoga has yielded several significant findings. These include a reduction in anxiety levels, an increase in galvanic skin response (GSR) indicating enhanced relaxation, an increase in alpha brainwave activity associated with a calm mental state, a decrease in blood pressure, improvements in the body's response to tilt and cold pressor challenges, a decrease in catecholamines (stress hormones), and a decrease in plasma renin activity. These changes are indicative of a reduction in sympathoadrenal activity and renin-angiotensin system activity, as well as an improvement in baroreceptor sensitivity(Selvamurthy W *et.al*) Yoga and Ayurvedic diet recommendations are recommended for women who have been diagnosed with Hypothyroidism to assist in reducing their body mass indexand addressing weight concerns in the waist circumference and hip areas. Numerous studies have already demonstrated that the combination of yoga and ayurveda dietary adjustments yields positive outcomes in terms of weight circumference and low-density lipoprotein (LDL) reduction. The inclusion of astringent, pungent, and bitter food items, as outlined, is instrumental in rebalancing the Kapha, Pitta, and Vata doshas. These food choices, when coupled with yoga, are also instrumental in lowering hyperlipidemia by regulating blood glucose levels in the body.

As a result of yogic practices and dietary modifications, the body experiences a reduction in ama (toxic waste), which leads to a significant improvement in iron absorption within the bloodstream. This boost in mineral levels facilitates effective communication among the body's trillions of cells and enhances processes such as the conversion of T4 to T3 within the blood and cell membranes. The combination of Ayurvedic dietary choices and yogic practices also aids in the decalcification and soothing of the hypothalamus and pituitary gland. Consequently, this positive influence on the Hypothalamic-Pituitary-Thyroid (HPT) axis results in a decrease in Thyroid Stimulating Hormone (TSH) levels, ultimately alleviating the symptoms of hypothyroidism in women.

Contributing Factors to Hypothyroidism
Hashimoto's disease, Thyroiditis (inflammation of the thyroid), Congenital hypothyroidism (present at birth), Surgical removal of part or all of the thyroid, Thyroid radiation treatment, Certain medications, Iodine deficiency.

Indications
Fatigue, weight gain, sensitivity to cold, joint and muscle pain, dry skin or thinning hair, irregular menstrual periods or fertility issues, reduced heart rate, and feelings of depression.

Potential Complications
Goiter, Heart Problems, Myxedema, Infertility, Birth Defects, Mental Health Challenges.

Diagnostic Procedure
Evaluation through blood samples, assessing levels of TSH, T3, and T4 hormones.

Treatment Approaches
Thyroid Replacement therapy using medications like Levothyroxine, accompanied by lifestyle modifications, including exercise and adherence to a Yoga & Ayurvedic Diet.

Study Goals
Investigate if there is a significant difference in selected physical variable Waist Circumference (WC) and biochemical variable Low-Density Lipoprotein (LDL) among middle-aged women diagnosed with Hypothyroidism as a result of practicing Yoga & Ayurvedic Diet.

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Problem Statement
The study aimed to determine the efficacy of Yoga & Ayurvedic Diet on specific physical variables, including Waist Circumference (WC), and biochemical variables such as Low-Density Lipoprotein (LDL), among middle-aged women diagnosed with Hypothyroidism.

Hypothesis
The study postulated that there would be noteworthy differences in Waist Circumference and Low-Density Lipoprotein (LDL) levels between the Yoga & Ayurvedic Diet group and the control group among middle-aged women diagnosed with Hypothyroidism.

Inclusion Criteria
- Women diagnosed with Hypothyroidism (aged 35-60 years)
- T3 levels within the normal range (2.0-4.0 pg/ml); T4 levels within the normal range (0.8-1.8 ng/dl)
- TSH levels between 4.2 mIU/l and 10 mIU/l, within the normal range (0.5-4.20 mIU/l)
- Willing and capable of independently attending the intervention/control sessions
- Capable of providing written informed consent.

Exclusion Criteria
- Individuals who have undergone any form of thyroid surgery
- Individuals diagnosed with cardiac disorders, morbid obesity at stage III, uncontrolled diabetes, pulmonary dysfunction, and carcinomas
- Individuals suffering from congenital or secondary hypothyroidism
- Women who are pregnant, lactating, or planning pregnancy in the near future
- Those dependent on drugs and alcohol
- Individuals unwilling to participate in the study

METHODOLOGY

This study is ethically approved by Institutional Human Ethics Committee with having reference number, MMCH & RI IEC/PhD/30/JUNE/22. In a randomized experimental study, 30 middle-aged women with Hypothyroidism were randomly selected using a random sampling group design from Chennai, aged 35 to 60 years. They were divided into two groups, Group I and Group II, each consisting of 15 subjects. The hypothesis posited that significant differences would emerge due to the implementation of Yoga & Ayurvedic Diet on Waist Circumference and Low-density lipoprotein among middle-aged women diagnosed with Hypothyroidism compared to the control group. Prior to the training program, a pre-test was conducted for both Group I and Group II on the selected dependent variables. Group I underwent Yoga & Ayurvedic Diet treatment, while Group II (Control Group) did not receive any specific treatment but engaged in active rest. Following an experimental period of eight weeks, both groups were retested on the same selected dependent variables. Analysis of covariance (ANCOVA) was employed to determine significant differences between the experimental group and the control group.

RESULTS AND DISCUSSION

The data related to the variable collected from both groups before and after the training period underwent statistical analysis through Analysis of Covariance (ANCOVA) to ascertain significant differences. The hypothesis was tested at a confidence level of 0.05, and the results are presented in Table I and Table II. In Table I, the obtained F value for pretest scores in both the experimental and control groups was 0.07, which was lower than the required F value of 4.2 for significance at the 0.05 level. This indicates that there was no significant difference between the groups at the pretest, and the randomization at the pretest was equal. However, the analysis of posttest scores showed a significant difference between the groups, with an obtained F value of 18.15 exceeding the required F value of 4.2. This suggests

that the differences between the posttest means of the subjects were significant. Considering both pretest and posttest scores among the groups, adjusted mean scores were calculated and subjected to statistical treatment. The obtained F value of 84.18 surpassed the required F value of 4.21. This indicates a significant difference among the means due to eight weeks of Yoga & Ayurvedic Diet on waist circumference in centimeters, in line with a study conducted by Geetha B. Shetty *et.al.,* (2020). The ordered adjusted mean on waist circumference in centimeters was visually presented through a bar diagram for a better understanding of the study results, as shown in Figure-1.

The study results revealed that Group I exhibited significant differences in Waist Circumference due to the implementation of Yoga & Ayurvedic Diet. Consequently, the hypothesis was accepted at a confidence level of 0.05. These findings align with observations made by experts, including Geetha B. Shetty *et.al.,* (2020). In Table II, the obtained F value for pretest scores, 0.03, was lower than the required F value of 4.2 for significance at the 0.05 level. This indicates no significant difference between the groups at the pretest, affirming equal randomization. However, posttest score analysis revealed a significant difference between the groups, with an obtained F value of 18.23 exceeding the required F value of 4.2. This suggests significant differences between the posttest means of the subjects. Considering both pretest and posttest scores among the groups, adjusted mean scores were calculated and subjected to statistical treatment. The obtained F value of 194.60 surpassed the required F value of 4.21, indicating a significant difference among the means due to eight weeks of Yoga & Ayurvedic Diet on Low-Density Lipoprotein in mg/dl, consistent with a study by Rukamani Nair *et.al.,* (2021). The ordered adjusted mean on Low-Density Lipoprotein in mg/dl was presented through a bar diagram for a clearer understanding of the study results, as shown in Figure - 2. The study results demonstrated that Group I exhibited significant differences in Low-Density Lipoprotein levels due to the implementation of Yoga & Ayurvedic Diet. Consequently, the hypothesis was accepted at a confidence level of 0.05. These findings align with observations made by experts, including Rukamani Nair *et.al.,* (2021).

CONCLUSION

In summary, the study found significant reductions in both Waist Circumference (WC) in centimetres and Low-Density Lipoprotein (LDL) in mg/dl due to the implementation of Yoga & Ayurvedic Diet in Group I compared to the Control Group among middle-aged women diagnosed with Hypothyroidism. This leads to the conclusion that Yoga & Ayurvedic Diet is beneficial for middle-aged women with Hypothyroidism.

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Table 1: Analysis of Covariance Of The Means Of Experimental Group And The Control Group On Waist Circumference In CMS

TEST	EXP. GROUP	CONTRO L GROUP	SOURCE OF VARIEN CE	SUM OF SQUARE S	DEGREE OF FREEDOM	MEAN SQUAR ES	OBTAIN ED F-RATIO
PRE	97.00	96.13	Between	5.63	1	5.63	0.07*
			With In	2414.23	28	86.22	
POST	83.53	95.63	Between	1098.07	1	1098.07	18.15*
			With In	1693.97	28	60.50	
ADJUSTED POST	83.21	95.95	Between	1213.92	1	1213.92	84.18*
			With In	389.34	27	14.42	

* Significant at 0.05 level of confidence. (Table F ratio at 0.05 level, of confidence for Df 1 and28=4.2, 1and 27= 4.21)

Table 2: Analysis of Covariance of the Means of Experimental Group and the Control Group On Low Density Lipoprotein In mg/dl

TEST	EXP. GROUP	CONTRO L GROUP	SOURCE OF VARIE NCE	SUM OF SQUARE S	DEGREE OF FREEDO M	MEAN SQUARE S	OBTAINE D F-RATIO
PRE	151.87	152.40	Between	2.13	1	2.13	0.03*
			With In	2235.33	28	79.83	
POST	139.47	152.80	Between	1333.33	1	1333.33	18.23*
			With In	2048.13	28	73.15	
ADJUSTED POST	139.71	152.56	Between	1236.21	1	1236.21	194.60*
			With In	171.52	27	6.35	

*Significant at 0.05 level of confidence. (Table F ratio at 0.05 level, of confidence for Df 1 and 28 = 4.2, 1 and 27=4.21)

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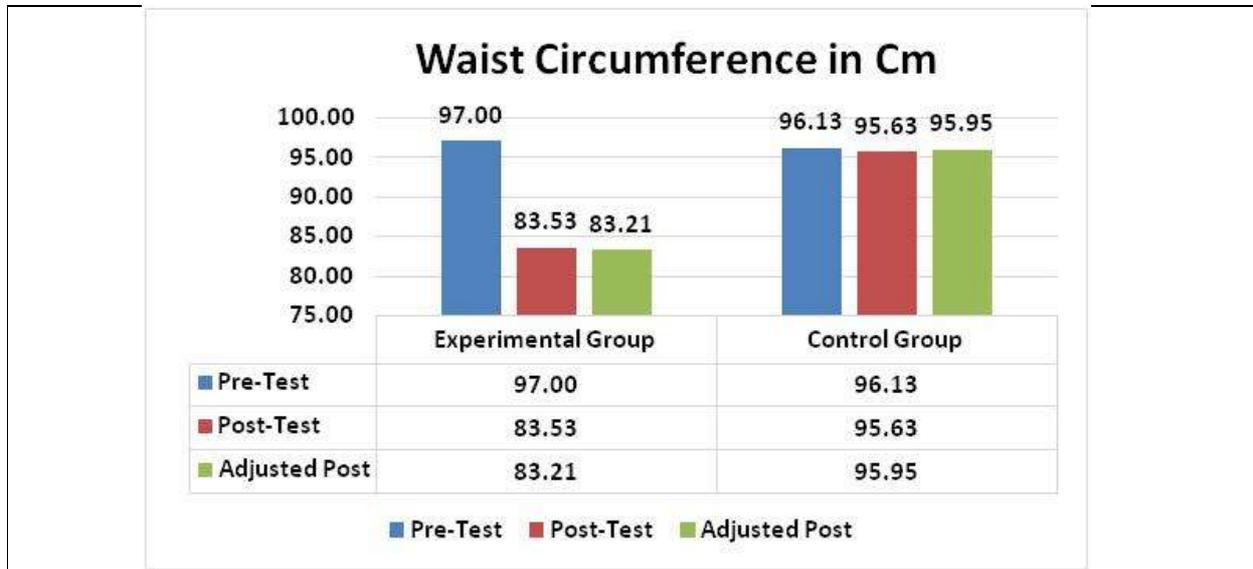
Figure – 1 Bar diagram showing the mean differences among the groups on waist circumference in cms
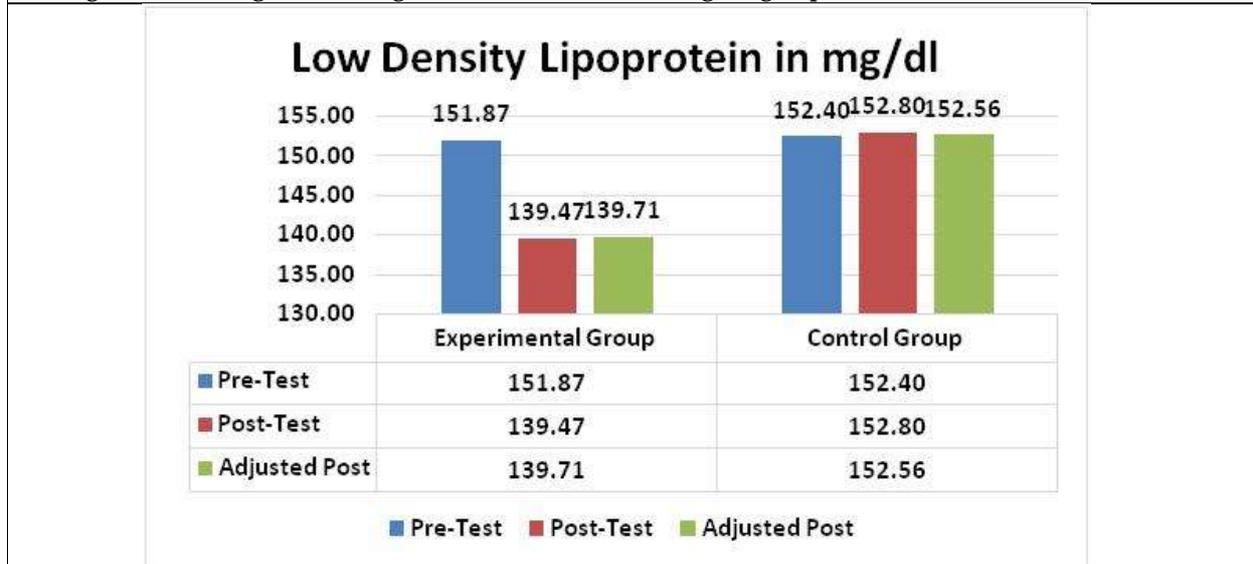
Figure – 2 Bar Diagram Showing The Mean Differences Among The Groups On Low Density Lipoprotein In mg/dl

REVIEW ARTICLE

A Review on Environment Friendly Bio Fuels

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ABSTRACT

Bio-Fuels have emerged as a promising solution to the global energy and environmental challenges of the 21st century. Bio-Fuels are renewable energy sources derived from biological materials such as plants, algae, and waste organic matter. They offer an environmentally friendly alternative to conventional fossil fuels, as they have the potential to significantly reduce carbon dioxide emissions when integrated into the energy mix. Bio-Fuels come in various forms, with the two most prevalent types being bio-ethanol and biodiesel. Bio-ethanol is primarily produced from crops like corn and sugarcane, while biodiesel is typically derived from vegetable oils and animal fats. This article gives a comprehensive review on the research and evolution of Bio-Fuels and the important findings in this area of study. This work also makes an efforts to address the current challenges in production and availability of Bio_ Future needs.

Keywords: Bio-Fuels, Emissions, Sustainable energy, Renewable Energy

INTRODUCTION

Bio-Fuels offer a sustainable and renewable energy solution that can significantly reduce greenhouse gas emissions, enhance energy security, and promote sustainable agriculture practices. Their development and utilization will play

a crucial role in transitioning towards a greener and more sustainable energy future. They can be produced domestically, reducing the need for energy imports and enhancing national energy self-sufficiency. The production of biofuels also aligns with sustainable agriculture practices. Many biofuel feedstocks can be grown on marginal lands, reducing competition with food crops and mitigating land-use conflicts. The following are some of the important contribution in the area of Bio-fuels research. Alternate fuels for combustion ignition (CI) and spark ignition (SI) motors have become amazingly basic on account of the expanded worries on climate security, the need to diminish overdependence on oil and various other financial viewpoints [1]. Because of the expanding attention to the exhaustion of petroleum derivative assets and natural issues, biodiesel turned out to be an ever-increasing number of alluring in the new years. Biodiesel creation is a promising and significant field of examination because of the importance it gains from the rising petrol cost and its natural benefits. The utilization of biodiesel in the auto industry, the difficulties of biodiesel industry advancement, and the biodiesel strategy are talked about too [2]. As one of the significant makers and customers of sugars and the second crowded country, India gives a high need to food creation. Notwithstanding, the Indian creation of bio-ethanol can be visualized effectively and primer examinations show a promising road. In the long haul, lignocellulose-to- ethanol is the most reasonable pathway according to a natural perspective. Be that as it may, its creation cost should be diminished for allowing this interaction to drive forward the methodology of biomass-to- ethanol around the world [3]. Practically all the current fuel ethanol is created from palatable sources (sugars and starch), lignocelluloses biomass (LCB) has attracted a lot of consideration on ongoing occasions. Nonetheless, the transformation effectiveness just as ethanol yield of the biomass varies enormously regarding the source and nature of LCB, fundamentally because of the variety in lignocelluloses content. As endeavors to abuse LCBs into business ethanol creation, late examination endeavors have been dedicated to the techno-monetary upgrades of the general change measure. A variety of biomass, innovative methodologies, and microbial commitment to the change of LCB into ethanol are being done [4]. The new advances in the pretreatment of lignocelluloses biomass, with a consideration on the use of green solvents, including ionic liquids and significant eutectic solvents, followed by enzymatic saccharification using assistant proteins for the gainful saccharification of pretreated biomass is being completed. The joining of different advances is suggested and inspected for successful biomass utilization and improved ethanol yields and benefit [5].

The full environmentally friendly power creation of the Brazilian sugarcane industry includes, other than ethanol creation, the utilization of biogases and straw. The biogases is scorched in factories for cogeneration and any overflow bioelectricity is offered to the matrix. While 40% of the straw should be left for soil security, 60% could be utilized for cogeneration. This examination assessed the energy reconciliation of original (1G) and second- age (2G) ethanol tasks and the subsequent overflow energy. The work utilized trial and distributed information of higher calorific estimations of these buildups too of lignin, a strong interaction stream [6]. Nigella Sativa is such a plant- animal category native to Middle-east, Eastern Europe, and the Asian Subcontinent. Dark cumin seeds got from N. Sativa are one of the recognized biomasses to create biodiesels for the utilization in an unmodified CI motor. The burning attributes of the NSME20 mix additionally shown comparable examples like diesel fuel with a slight decrease in chamber pressing factor and warmth discharge rate. At long last, it has been reasoned that the recently evolved Nigella sativa methyl ester can be utilized as economical biofuel for different energy applications in the current situation[7].Microalgae have as of late pulled in impressive interest around the world, because of their broad application potential in environmentally friendly power, biopharmaceutical, and nutraceutical ventures. Microalgae are inexhaustible, supportable, and conservative wellsprings of biofuels, bioactive therapeutic items, and food fixings. As biofuels, they are an ideal substitute to fluid petroleum products regarding cost, inexhaustibility, and ecological concerns. Microalgae have a critical capacity to change environmental CO_2 over helpful items like starches, lipids, and other bioactive metabolites [8].

Microalgae are autotroph organic entities that use light energy to incorporate different high- esteem bioactive mixtures like polysaccharides, proteins, and lipids. Because of its quick development rate and capacity to get by in a brutal climate, microalgae these days are applied in different mordern regions. The way toward acquiring microalgae- based biomolecules begins with the determination of appropriate microalgae strain, development, trailed by

downstream handling of the biomass (i.e., pre-treatment, reaping, extraction, and cleansing). The final results of the cycles are biofuels and other significant bioproducts [9].

Algae are progressively arising as quite possibly the most encouraging feasible and long haul wellsprings of biomass and oils for fuel, feed food, and other co-items. The primary centre was in the development and utilization of microalgae on biofuel recuperation. Essentially every one of these advantages comes from the way that these plants have advanced more than billions of years to create and store energy like oil, and they do this more proficiently than some other known regular or designed cycle [10].

ADVANCEMENTS

Different methodologies like the fitting of hydrolytic chemicals to build the particular action of specific enzymatic response and commitments by conspicuous researchers for compelling use of celluloses and hemicelluloses for bioethanol creation have been examined. We have additionally featured the correlation on the usage of basic sugars (hexoses and pentoses) by microscopic organisms and growths and depicted the new progressed methods used for the creation of ethanol [11].

Imidazolium-based ionic fluids have been pulled into huge consideration in making biofuels from biomass. Because of the great thickness, the natural dissolvable overall is applied to improve the properties of the ionic fluids. The kinematic consistency is estimated by a Ubbelohde narrow viscometer at air pressure (0.0967 MPa) from 303.15 K to 353.15 K. The Vogel-Fulcher- Tammann condition is acquainted with connecting the thickness [12]. A nonlinear ideal H- boundlessness control approach is used for bioreactors focusing on improved biofuels creation. The powerful model of the bioprocess occurring in the bioreactor goes through surmised linearization around impermanent equilibria which are recomputed at every cycle of the control strategy. For the around linearized model of the bioprocess, an H-endlessness input regulator is planned. Under moderate conditions, it is demonstrated that the control circle is all around the world asymptotically steady. The proposed control strategy settles at long last the nonlinear ideal control issue for bioreactors in a computational effective and of demonstrated union way [13].

The physiological properties, including biochemical arrangement and cell divider thickness, of microalgal species, remarkably affect the pretreatment of biomass and its further transformation to biofuels. Different biofuels (bioethanol, higher alcohols (C3-C5), and biodiesel) were delivered utilizing energy-effective microwave pretreatment, progressive sugar/protein maturation, and lipid transesterification from three microalgal strains. This proposes that the utilization of a fitting pretreatment strategy for microalgal strains having diverse physiological properties is fundamental for improving the extraction productivity and change of biomass to biofuels with less waste creation [14].

Because of the modern turn of events and improved expectations for everyday comforts, utilization of raw petroleum expanded to another stature, and because of which our air got dirtied to a degree of implosion. Substitute energizes like biodiesel, biogas, packed flammable gas (CNG), hydrogen and melted oil gas (LPG) could be viewed as an option in contrast to traditional raw petroleum. Execution and emanation of inner burning motors utilizing substitute energize assume a significant part in its turn of events. This effect on different working boundaries and conditions for inward ignition motor running on various substitute energizes. The ash particles affect the climate [15]. Bio-oil and bio-crude are the fluid biofuels acquired from lignocellulosic biomass through pyrolysis and liquefaction, individually. Bio-oil is viewed as sub-par fuel for a regular diesel motor, and redesigning is required. The physical-compound properties of bio-oil can be improved fundamentally by presenting the emulsion innovation of blending bio-oil with diesel, biodiesel, and mixed bio-oil with methanol, ethanol, and fish oil. The essential burning examinations including vanishing can be separated into three gatherings, for example, flawless bio-oil, emulsion, and mixed bio-oil. The use of splash, ignition and outflow attributes in the use of bio-oils for warmth and force age is likewise. The physicochemical properties, principal ignition studies, and burning and outflow attributes of pyrolytic oil are presented [16].

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A huge issue of biofuels is their low oxidative solidness, which could be improved by the expansion of manufactured cell reinforcements. Hence, the checking of cell reinforcement content assumes a significant part in utilizing biofuels. The new strategy for volumetric assurance of manufactured cancer prevention agent propyl gallate (propyl 3,4,5-trihydroxybenzoate) in biofuels utilizing direct scope voltammetry with a gold circle terminal as the working cathode was created. The proposed technique can be utilized to control the nature of biofuels [17]. Lignocellulosic biorefinery offers affordable and manageable creation of energized and synthetic compounds. In any case, the consecutive and moderate change of xylose into target items stays one of the primary difficulties for acknowledging proficient mechanical lignocellulosic biorefinery. An incredible blended sugar is made for the co-maturing strain of *S.cerevisiae*, XUSEA, with improved xylose transformation limit during synchronous glucose/xylose co-ageing. The exhibition of the recently designed strain with improved xylose catabolism was also supported by hoisting maturation temperature and, consequently, essentially diminished the co-ageing time [18].

To help the lignocellulosic biomass-based bio-economy, much thought is needed to advance xylose- utilizing adequacy, utilizing rehashing cell regulatory associations, to achieve incredible co- development of xylose and other cellulosic carbon sources under present-day conditions, and to mishandle the ideal characteristics of yeast xylose processing for conveying various fills and artificial materials [19]. The creation of biofuels from lignocellulosic biomass stays a perplexing test in modern biotechnology. Endeavors to utilize yeast for transformation face the topic of which have an organic entity to utilize, counterbalancing the simplicity of hereditary control with the guarantee of strong mechanical aggregates. Various designing systems for extending substrate goes and differentiating results of *S. cerevisiae* have been created. Different yeasts, by and large, do not have these instruments, yet harbor predominant aggregates that could be abused in the brutal cycles needed for lignocellulosic biofuel creation. Conversely, oleaginous yeasts, for example, Yarrow IA lipolytic fit for delivering high titers of lipids are quickly progressing as far as the instruments accessible for their metabolic control [20]. Self- fueled biosensor, as another detecting stage, uses biofuel cells as a simultaneous force source and biosensor framework, with the benefits of no outer force source, basic instrumentation and simple scaling down. Then, persuaded by biomimetics for the epitome of fragile tissue inside cautious exterior in nature, the embodiment of normal macromolecules by metal regular designs (MOFs) have been winded up being a convincing system for improving the biocatalytic activity in keeping up natural limits [21]. Biofuel cells utilize compound responses and organic impetuses to deliver electrical energy, giving perfect and sustainable power. Enzymatic biofuel cells (EBFCs) have promising attributes and likely applications as an elective fuel hotspot for low-power electronic gadgets. It likewise depicts how scientific methods can be utilized to follow the intermediates between the compounds inside the enzymatic course. We expect to show how a superior self-controlled sensor configuration dependent on EBFCs produced for ethanol recognition can be adjusted and carried out in power gadgets for biosensing applications [22].

Quite possibly the most referred to meanings of cosmology is "an express and formal determination of a conceptualization". Through conceptualization, pertinent ideas are recognized to unequivocally portray a wonder in a conventional machine-intelligible language. There are numerous utilizations of metaphysics designing, like structure semantic web frameworks, working with information the board, supporting the coordinated appraisal of rural frameworks, organizing information for supportability science and building up an undertaking focused portable help route framework [23]. Conceptual Nano and fine particles have caused genuine medical conditions. Notwithstanding the constant decrease of their fixations, the excess sums are as yet thought to be an issue in pressure start motors. A TD 313 Fiat diesel rig (a 4-stroke, 4-chamber, water-cooled and direct infusion motor) is used. The centralizations of all PM sizes were diminished when the motor was running at medium speed and burden. On the other hand, fixations expanded when the motor was running at low and high loads and velocities. Results exhibited that biokerosene is better compared to biodiesel–diesel mixes in decreasing PM emanations [24].

Options of non-renewable energy source assets as inexhaustible biodiesel fuel and alcohols addresses the most recent innovation to be created related to the declining of petroleum derivative assets alongside higher raw petroleum cost. In this investigation, four-stroke, single chamber, and direct infusion diesel motor execution and emanations are

assessed. The test results show expanding in brake explicit fuel utilization with the expanding of higher mass parts of liquor mixes, which is credited to diminishing the lower warming worth (LHV) of the mixes.

Higher brake warm effectiveness contrasted with diesel fuel was delivered. An expressive decrease in carbon monoxide (CO) of (16.1% - 46.6% vol.) with complete unburned hydrocarbons (UHC) diminishing of (7.4% - 25.3% ppm), and nitric oxides (NOx) of (8.5% - 23.5% ppm). Biodiesel and alcoholic mixes are reasonable to be utilized as options in contrast to diesel without the requirement for any adjustments in customary diesel motors [25]. The toxins come about because of Kerosene burning in the stonemasonry stoves, which emanates variable kinds of toxins to the air and items. Biofuels delivered from palatable food squanders have been added to lamp oil at various rates to diminish harmfulness levels, most eminently the lead partition in lamp oil. The aftereffects of the investigation show that the kerosene biofuel mixes are spotless and liberated from lead and sulfur compounds, notwithstanding the accessibility of creative potential [26]. The issues of expanding the proficiency and improving the natural nvitingness of warmth motors are pressing issues of humankind. The article manages the utilization of biofuel as fuel for responding to inner burning motors. A short outline of flow research on this point is introduced in the article. In light of the aftereffects of mathematical recreation, another plan of the spout atomizer is proposed, the ideal fuel infusion advance point and the fuel supply law for the fundamental methods of diesel motor activity are chosen. The proposed measures have prompted an expansion in the successful catalyst (to 5%), a decline in explicit fuel utilization (up to 6%) and an improvement in natural invitingness [27]. The common dissolvability of two fills should be improved by adding co-solvents. In this way, three butanol isomers were chosen to contemplate the solubilization capacity and fuel properties improvement in the mixes of low- carbon liquor and rapeseed oil. Results show the situation of the stage limit increments because of low-carbon liquor broke up into rapeseed oil with the continuous expansion of co- dissolvable until the presence of one-stage fluid in both full scale and miniature perceptions. The appropriate elective fuel framework can be set up as per the fuel prerequisites of various motors [28]. Theoretical The immediate utilization of corn oil as bio-fuel in motors is promising, however, the Transesterification for plant oil burns through enormous energy. The transcriptome examination of corn seed, unsaturated fat desaturase 2 (FAD2), stearoyl-ACP desaturase (SAD) and phospholipid: diacylglycerol acyltransferase (PDAT) were the vital catalysts in the blend of unsaturated fats. In this way, corn oil can be utilized straightforwardly by mixing with low- carbon alcohols and co-solvents, in the interim the transcriptome investigation of the unsaturated fat biosynthesis gives a novel plan for the use of corn oil in motors[29].

Transesterification of a grain of corn oil tests in KOH reactant and supercritical methanol were concentrated without utilizing any impetus. Biodiesel, an option biodegradable diesel fuel, is gotten from fatty oils by Transesterification with methanol and ethanol. In Transesterification, free unsaturated fats and water consistently produce adverse consequences, since the presence of free unsaturated fats and water causes cleanser development, devours impetuses, and diminishes impetus viability, all of which bring about a low transformation[30]. There are numerous significant reactant factors like impetus type and piece, support type and pretreatment conditions (for example calcination temperature and time) which are used to accomplish significant returns for the transesterification response. Moreover, operational conditions like response temperature, liquor type, liquor to oil molar proportion and blending speed have likewise very high importance [31]. The rising worldwide interest for practical energy assets is bringing about a sped up expansion in biodiesel utilization. To lessen energy utilization and the measure of wastewater created, just as to stay away from the creation of wasteful finished results, classes of compounds, particularly lipases, are as a rule effectively investigated as substitutes to synthetic impetuses. This article features a few parts of lipase-catalyzed biodiesel creation. As per the writing, elective arrangements incorporate the utilization of ease, whimsical crude materials, new backings, the explanation of systems of lipase immobilization, and ideal plans and operational settings for bioreactors [32].

The expanded worldwide interest in biofuels has provoked the quest for options in contrast to palatable oils for biodiesel creation. Given the bounty and cost, squander and nonedible oils have been researched as possible feedstocks. To grow the practicality of enzymatic biodiesel creation, extensive exertion has been coordinated toward measure advancement regarding biodiesel efficiency, application to wide scopes of the substance of water and

unsaturated fats, increasing the value of glycerol results, and bioreactor plan. Nonetheless, it can likewise be anticipated that further interaction advancement will prompt a decreased expense in chemical arrangement just as in downstream cycles[33]. Unique Biodiesel, a sustainable fuel, has extraordinary potential in satisfying a consistently expanding transport fuel interest. Lipases are reasonable to creating a cleaner and greener biodiesel under milder conditions since it produces fewer squanders than the regular synthetic interaction. Obstructions related to the mechanical achievability of the enzymatic framework are principally a direct result of high impetus creation and sterilization costs, the reasonably more sluggish reaction rate, and lipases inactivation achieved by methanol and glycerol, which may be overpowered by sub-nuclear headways[34].

Difficulties related to worldwide asset exhaustion, anthropogenic ozone-depleting substance age and an unnatural weather change, because of broad non-renewable energy source use have catalyzed the investigation of pathways for elective biofuel creation to decrease undesirable natural results. Critically notwithstanding, existing biofuel creation measures have been portrayed by negative natural results to a great extent because of optional poisonousness impacts emerging from the utilization of mineral acids (or mineral soluble bases) to catalyze biofuel creation measures. To hence improve the ecological exhibitions of biofuel creation measures, a few analysts have researched the plausibility of upgraded and maintainable naturally kindhearted lipase-catalyzed biofuel creation measures [35]. Biodiesel is one of the significant biofuels and a spotless fuel source as an option to petroleum-based diesel fills. Biodiesel enjoys a few benefits and weaknesses. Transportability, high burning effectiveness, low sulfur and sweet-smelling content, high cetane number and biodegradability are benefits of biodiesel. Burdens of biodiesel are high consistency, lower energy content, high cloud and pour point, high nitrogen oxide discharge, lower motor speed and force, injector cooking, excessive cost and motor disintegration [36].

The investigation of CPO fluid waste-based biodiesel creation innovation has been directed. The points of this investigation were to get biodiesel from Industrial fluid misuse of CPO preparing and to distinguish the sort of methyl-ester compound of the biodiesel. The creation of biodiesel was applied in two stages of responses; esterification response utilizing H_2SO_4 and transesterification utilizing CaO impetus at 60 °C for 2 h. GC-MS examination result showed that methyl ester from fluid misuse of CPO contains methyl hexadecanoic 12.87%, methyl 9- octadecanoic 19.98%, methyl 8ctadecenoate 5.71%, and methyl 8,11-octadecadienoate 10.22% [37]. Utilized browning oil contains synthetic segments both from warming and singed food content. The work behind this is to comprehend the interaction of degumming in searing oil that is earthy coloured to dark after compound corrosive refining with Phosphoric corrosive (H_3PO_4). The scientific technique utilized was GC-MS, upheld by thermogravimetry and FTIR Analysis.

Six (6) tops with m/z 88 as ethyl ester part markers and supposedly there are two pinnacles of ethyl linoleate and ethyl oleate as unsaturated fats in Gas Chromatography-Mass Spectrometry[38]. Developing concern for energy assets and the climate has expanded interest in the investigation of elective wellsprings of energy. To meet expanding energy necessities, there has been developing interest in elective fills like biodiesel to give an appropriate diesel oil substitute for inner burning motors. Biodiesels offer a promising option in contrast to diesel oil since they are inexhaustible and have comparative properties. It is a promising substitute as an elective fuel and has acquired huge consideration because of the anticipated brevity of customary energizes and natural concern. The usage of fluid fills, for example, biodiesel created from squandering cooking oil by transesterification measure addresses quite possibly the most encouraging alternatives for the utilization of customary petroleum products [39].WTO (squander transformer oil) has been considered as a trade for diesel as drawing from the wellspring of energy from byproducts would help lessen the fuel cost. In that capacity, WTO was exposed to fuel refinement measure by trans-esterifying it in two phases utilizing corrosive and salt impetuses [40].

Plenty of examinations were directed on IDI motor with different biodiesels. Audit of the consequences of these undertakings with different added substances and mixes with or without supercharging of the motor are introduced in this section. Motor chamber vibrations (reflect ignition excitation) as FFT and time waves were recorded at spiral focuses and vertical on the chamber body to survey the burning affinity in all instances of studies. The outcomes

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with relative advantages are counted [41]. Contrail cirrus represents a significant portion of aeronautics environment sway. Here it present extraordinary perceptions from two DLR-NASA aero plane crusades that deliberate exhaust and contrail attributes of an Airbus A320 consuming either standard stream powers or low sweet-smelling economical aeronautics fuel mixes. The outcomes show that ash particles can direct the quantity of contrail cirrus ice precious stones for current emanation levels. Decreased contrail ice numbers cause less energy statement in the climate and less warming [42].

In the last quarter of 2018, low enhanced uranium dioxide fuel with zirconium composite cladding was utilized effectively to change over the centre of NIRR-1 from HEU to LEU fuel and the eliminated centre got back to the nation of beginning. The target of this review was to examine the chance of powering a similar framework with substitute The PC programming chose for these examinations were the SCALE code framework and the VENTURE PC. While the SCALE code framework was utilized to produce an appropriately found middle value of multigroup cross- segment library for the examined LEU centre models for the NIRR-1 framework, the VENTURE PC was used to give criticality data, not many gathering motions and force thickness circulations inside the centre of the demonstrated framework[43]. Globalization, industrialization and urbanization have prompted the worldwide energy emergency. There is an extraordinary interest in non-environmentally friendly power sources to meet the energy needs. This thusly has prompted the fatigue of petroleum derivatives. This has prompted the advancement of the age of biofuels. The current review plans to give an outline of the advancement of the various ages of biofuels for practical improvement in the coming future for worldwide development. It gives a plan to investigate cutting edge biofuels to meet our energy needs. Even though biofuel is certainly not an 'Environmentally friendly power energy", it very well may be utilized as a substitute energy source. Great energy approaches ought to likewise be declared by the states to execute productively and viably [44].Energy interest on the planet is these days becoming farther of cutoff points of installable age limit. Thusly, future energy requests ought to be met and improved proficiently and safely. Energy arrangements ought to be upheld by using sustainable power sources. Cost, a portion of the overall industry and strategy are the principal hindrances for the advancement of an environmentally friendly power. In the procedure plans of numerous nations, the reasonable advancement according to the boundaries. New empowering innovations identified with sustainable power sources will likewise assist with diminishing ecological expenses, and subsequently, the energy frameworks will be worked both safely and financially without natural issues [45].

Energy is the driver in the financial advancement of any country. Normally, non-industrial nations like India will represent a 25% climb in overall energy interest by 2040 because of the expansion in the per capita pay and quick industrialization. Among the conceivable fluid fills, methanol is exceptionally encouraging. Methanol is a solitary carbon particle compound and can be created from a wide assortment of sources like gaseous petrol, coal, and biomass. The properties of methanol are favourable for use in fuel motors since it has a supercharged number and fire speed. Other potential employment of methanol is: as a cooking fuel in rustic regions, and as a fuel for running the energy components. The current review surveys the constraints in the hydrogen economy and why moving towards a methanol economy is more helpful [46]. Proton trade film power devices have been as of late created at an expanding pace as perfect energy change gadgets for fixed and transport area applications. High platinum cathode loadings contribute fundamentally to costs. This is the reason further developed impetus and backing materials just as impetus layer configuration is fundamentally required. Late advances in nanotechnologies and material sciences have prompted the disclosures of a few profoundly encouraging groups of materials. These incorporate platinum-based compounds with shape-chose nanostructures, platinum-bunch without metal impetuses, for example, metal-nitrogen-doped carbon materials and alteration of the carbon backing to control surface properties and ionomer/impetus cooperations. This audit centres around this load of late turns of events and it closes with a conversation of future examination bearings in the field [47].

Strong oxide power modules (SOFCs) are power-producing gadgets with high efficiencies and are considered promising choices to alleviate energy and natural issues related to petroleum derivative advances. Nanoengineering of cathodes used for SOFCs has arisen as a flexible apparatus for fundamentally improving the electrochemical

exhibition however needs to beat issues for incorporation into useful cells appropriate for far and wide application. The combination of the nanoengineered cathode layers into customary anode-upheld cells empowered the accomplishment of high current densities at 0.7 V coming to ~2.2 and ~4.7 A/cm2 at 650 °C and 700 °C, separately. This outcome exhibits that tuning material properties through a compelling nanoengineering approach could altogether support the electrochemical presentation of cathodes for the advancement of cutting edge SOFCs with high force yield [48]. The current work is a work to deliver fluid fuel oil from plastic-based clinical squanders through warm breaking measures under oxidizing conditions. The blended plastics from clinical squanders were considered as a feedstock, destroyed into little pieces and warmed at 773 ± 10 K for 40 min with a warming pace of 20 K/min in a cluster reactor for warm breaking measure. The properties of fluid items were likewise inspected and contrasted with the business fuel oil. The normal yield of caramel and tacky fluid fuel was gotten to be 52 wt% and the gross calorific worth of the fluid was found 41.32 MJ/kg which is equivalent to that of business diesel. This investigation reasons that the fluid oil got from the warm breaking of blended plastics involved a composite combination of natural parts. A lot of non-corrupted constituents like plasticizers, forerunners, and so forth stayed in the item having some financial qualities with human wellbeing and ecological effects during consuming have been tended to in the recent concern [49].

The dried and pummeled clinical strong waste was pyrolyzed at 500 °C, and the parts and attributes were examined after the strong, fluid and gas items were gathered separately. The carbon content of strong items after sanitization was up to 63.13%, and the hotness esteem was 5454.54 kcal/kg. Moreover, to benefit as much as possible from the pyrolysis oil, the fluid item was isolated and purged by fragmentary buildup under the state of decompression. The impact of cycle boundaries, for example, vacuum degree and gathering temperature were underlined, and the ideal innovative condition was acquired as follows: vacuum degree 0.04 MPa, warming temperature 140 °C and the main stage consolidating temperature was 70 °C. The consistency estimation of the leftover high-thickness parts was expected to give information backing to the arrangement of tar connecting gear and channeling issues functional applications [50].

By vacuum pyrolysis, the elastic part of utilized tires is changed into oil and gas and the carbon dark filler is recuperated as pyrolytic carbon dark (CBP). In this way, CBP can supplant business carbon dark grades in specific elastic applications. CBP was effectively tried as a filler in the street asphalt. The complete pyrolytic oil can be utilized as a fluid fuel. The oil can likewise be refined into various portions: a light, a centre distillate and a substantial division. The light division was decidedly tried as a fuel added substance. Moreover, this portion contains significant synthetics, for example, d,l-limonene. The centre part was effectively tried as a plasticizer in rubbers. The pyrolytic gas can be utilized as a make-up heat hotspot for the pyrolysis cycle [51].

To enhance the fluid result of pyrolysis from as much as 500 g of polypropylene (PP) plastic waste, utilizing a proper bed type reactor in a vacuum condition (−3 mm H2O), to limit the oxygen entering the reactor. The fume moves through the 4-plate refining bubble cap plate segment for fractionation by using heat from the reactor. Interaction conditions at 500–650 °C and of 580 °C ideal fluid oil yield is 88 wt.%, including lamp fuel in the plate I with a volume of 350 ml, gas in plate II and III with a volume of 228 ml, and plate IV had no condensate. Gas yield is 5 wt.% and the rest is roast. The attributes of fuel got from plastic-like thickness, consistency, octane–cetane number, debris content and calorific worth have comparative properties with those of non-renewable energy sources [52]. The expendable needle is one of the significant things in clinical waste. Polypropylene (PP) is the primary constituent of a few needles, yet the majority of them have the body from PP and the cylinder from high thickness polyethene. These plastics have a high potential as hydrocarbons hotspots for the substance industry. In this review, Pyrolysis of waste needles was acted in a semi-cluster reactor comprised of hardened steel at a temperature scope of 400–550 °C and a warming pace of 20 °C min−1. The greatest (83 wt%) fluid yield was acquired at temperature 450 °C. FT-IR investigation of the pyrolysis oil showed the presence of alkanes, alkenes and aromatics rings. From GC–MS investigation, it was tracked down that the pyrolysis oil contains around 25 kinds of mixtures having carbon chain length in the scope of C10–C20. The actual properties of the pyrolysis oil were near a combination of diesel and petroleum [53].

CONCLUSIONS

Bio-Fuels represent a multifaceted solution to address some of the pressing challenges associated with traditional fossil fuels. They offer promise in terms of reducing greenhouse gas emissions, enhancing energy security, and promoting economic development. However, several critical factors must be considered to maximize their benefits while minimizing potential drawbacks Bio- Fuels offer a promising pathway to reduce carbon emissions and enhance energy security but require careful consideration of environmental, economic, and technological factors. Continued research, innovation, and sustainable practices are essential to realize the full potential of Bio-fuels as a viable and environmentally friendly alternative to fossil fuels. In summary, Bio-fuels hold promise as a transitional energy source that can contribute to reducing carbon emissions and enhancing energy security. However, their successful integration into our energy landscape requires a holistic approach, addressing environmental, technological, and policy challenges. With continued research, innovation, and responsible practices, Bio-fuels can play a significant role in the global effort to combat climate change and secure a sustainable energy future.

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Synthesis Spectroscopic Characterization, Physicochemical Properties and Biological Studies of Mo+6 and VO+4 Metal Complexes with an Azomethine Ligand

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ABSTRACT

The exploration of novel chemical compounds plays a pivotal role in the advancement of various scientific fields. In this context, the prepared and thorough investigations of Azomethine derivatives hold significance. The current study reports the synthesis of Schiff base ligand, N'-(2-hydroxy-3-methoxybenzylidene) benzo hydrazide (HL) by reversible condensation reaction of primary amine and carbonyl compound. Further, Schiff base ligand was utilized to prepare the Mo+6and VO+4 metal complexes M1L and M2L, respectively. A recent study focused on the synthesis of a Schiff base prepared from 4-Methylbenzoylhydrazine and 2-Hydroxy-m-anisaldehyde using a modified Sandmeyer's method. Notably, this synthetic approach resulted in the formation of distinctive color complexes, namely Mo+6 and VO+4 complexes with HL. The structural characterization of the synthesized Azomethine was meticulously carried out using a range of analytical techniques. UV-Vis spectrometry, Infrared spectroscopy, Elemental analysis, nuclear magnetic resonance, electron spin resonance, thermo gravimetric analysis, conduct ometric measurements, and vibrational spin magnetometry were employed

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to elucidate the molecular structures of these compounds comprehensively. Furthermore, the compounds were subjected to biological screening to assess their potential activity against various microorganisms. The study revealed noteworthy inhibitory effects of the synthesized compounds against bacterial strains like *Salmonella typhi*, *Enterococcus faecalis*, and *Escherichia coli*. This antimicrobial activity underscores the potential applications of these compounds in the field of medicine and pharmaceuticals.

Keywords: Synthesis, Characterization, Schiff base, Biological activity.

INTRODUCTION

Azomethine compound, also known as a Schiff bases, represent a versatile class of organic compound with a wide range of applications in various scientific and industrial fields. The compounds you are referring to are called imines. Imines are organic compounds characterized by the presence of a carbon-nitrogen double bond (C=N) within their structure. They are formed through a condensation reaction between a primary amine (RNH_2) and either an aldehyde (RCHO) or a ketone (RCOR'). This reaction is known as imine formation or imine synthesis. The general chemical reaction for imine formation can be represented as,

RCHO or RCOR' + RNH_2 → R_2C=NR' + H_2O

Metal complexes of Schiff bases have undergone thorough investigation in recent years   [1-2]. Their utility spans various crucial sectors, from their deployment as pesticides [3] to their roles as catalysts [6-8], antibacterial agents and antiviral [4,5]. Notably, the thermal behavior of transition metal complexes of Schiff bases has been a subject of extensive exploration [9-11]. In the current study, the author presents an innovative series of metal complexes featuring Mo^{+6} and VO^{+4}, coordinated with a Azomethine ligand derived from 4-Methylbenzoylhydrazine and 2-Hydroxy-m-anisaldehyde (HL). Rigorous characterization encompassing vibrational spin magnetometry, TGA-DTA, FT-IR, elemental analysis, ^{1}HNMR, UV-Visble Spectrometry, VSM, Conduct ometric measurements and ESR was performed to unravel bonding modes, geometries, and properties of these complexes. Additionally, a thorough assessment of the biological studies of both the ligand (HL) and their respective Mo^{+6}, VO^{+4} metal complexes (M_1Land M_2L) was undertaken.

MATERIALS AND METHODS

In the present study, analytical grades compounds were used. The utilized organic substances are methanol (AR-Loba, 99.8%), rectified spirit (Loba, 98%), Tri ethyl amine (F Iwasaki, I Tanaka), 4-Methylbenzoylhydrazine (Aldrich, 99%), and 2-Hydroxy-m-anisaldehyde (Aldrich, 99%). The inorganic substances are sodium acetate trihydrate (AR-Merck, 99.5%), Ammonium molydedate (AR-Merck, 99%), hydrochloric acid (AR-Fisher, 37%), Sodium Acetate (Anala R), Ammonium Meta vanadate (AR-Finar, 98%) and triple distilled water.

Preparation of Schiff base ligand (HL) and its metal complexes (M_1L and M_2L)
The suggested schematic representation of the HL, M_1L, and M_2L complexes were provided in Scheme 1, which were synthesized using a standard procedure as reported earlier [3,21].

Preparation of Schiff base ligand (HL)
4-Methylbenzoylhydrazine (3.00g) and 2-Hydroxy-m-anisaldehyde (3.04g) dissolved in 25ml methanol, refluxed with 1ml triethylamine for 3 hours. After cooling, pale yellow needle crystals formed, washed with methanol, dried, yielding pure product for analysis (Table 1).

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Preparation of compound M_1L and compound M_2L

In synthesizing Mo^{+6} and VO^{+4} metal complexes represented M_1L and M_2L, metal chloride salts of these metals were utilized. Dissolving 2.85g HL in methanol, adding 6.17g and 0.59g metal chlorides in CH_3COONa solution, refluxing for 6 hours, and isolating vibrant orange and pale green crystals. Purification, recrystallization, and vacuum drying yielded promising metal complexes. Analytical data in Table 1 offers systematic insights into properties.

RESULTS AND DISCUSSION

Characterization of FT- IR spectra

Comparative analysis of the IR spectra involved examining the HL ligand spectrum alongside those of the Mo^{+6} and VO^{+4} complexes. The relevant data were meticulously compiled in a Table 2, accompanied by corresponding assignments, while visual representation was achieved through Figures 1, 2 and 3. The initial FT-IR spectra of the HL ligand displayed a prominent broad peak at 1643 cm^{-1} [14], attributed to the -C=N stretching of the Schiff base group. In the context of the complexes, this band exhibited a downward shift to 1622 cm^{-1} and 1637 cm^{-1} [15] for the Mo^{+6} and VO^{+4} complexes. This shift indicated the participation of the Schiff base ligand (>C=N) in the complexation process, driven by a reduction in electron density on the Nitrogen atom. This alteration pointed to metal coordination through to the N atom. Transitioning to the FT-IR spectrum of this metals chelates, a conspicuous absence of stretching -OH bond was observed at 3558 cm^{-1} [16]. This absence signified proton displacement through the phenolic hydroxyl group upon complexations, underlining covalent bond between metal ions and oxygen from the phenolic group. Further analysis of the FT-IR spectrum of the Mo^{+6} and VO^{+4} complexes revealed the broad peak band [17] encompassing approximately 3348 cm^{-1} and 3418 cm^{-1}. This band was attributed to the stretching frequency -OH vibrations of H_2O molecules linked with in the complexes formation. Additionally, weak peak bands appear at 802.22 cm^{-1} and 816.48 cm^{-1} corresponded to the -OH wagging and rocking vibrations of coordinated H_2O molecule. Notably, a distinct sharp peak band emerged within the 938-952 cm^{-1} region, reflecting the presence of the stretching frequency (V=O) mode. Within the complexes, novel bands emerged that were absent in the ligands spectrum. Specifically, bands appear at 456 cm^{-1} and 448 cm^{-1} was recognized as stretching frequencies' of M-O, whereas bands at 822cm^{-1} and 752 cm^{-1} [18] was associated with the stretching frequencies of M-N [19-21].

Characterization of H^1 NMR spectra

H^1 Nuclear Magnetic Resonance spectrum of the HL and Mo^{+6} and VO^{+4} complexes were presented in Figure 4, 5, and 6, using DMSO-D6 as the solvent. Corresponding chemical shifts value were consolidated in Table 3. The HL exhibited a singlet peak appear at 2.38 ppm [21], attributed to proton bond to the Schiff base. Upon complexation, singlet experienced a downfield shift to 2.36 ppm and 2.34 ppm for the Mo^{+6} and VO^{+4} complexes, respectively. The shift indicated a shielding effect on the Schiff base group. This Proton associated with this aromatic ring formed a multiplet peak appear at 7.25 ppm, while the $–OCH_3$ group of protons displayed a singlet at 1.19 ppm. Notably, the proton of the phenolic group [22] displayed a singlet appear at 11.50 ppm in ligand spectrum, a signal that disappear in complexes. In H^1 NMR spectra of this Mo^{+6} and VO^{+4} complexes, the peak appear signal corresponding to the Schiff base proton experienced a shift from 2.38 ppm to 2.36ppm, 2.34 ppm. The shift signified the shielding effect on the Schiff abse group. These protons of the aromatic ring within the 7.25 - 7.28 ppm range [22] exhibited broad peak and less intensity signals in the complexes compared to the Azomethine. Within the complex, protons of the aromatic ring at 7.25 - 7.28 ppm displayed broader and less intensity signals, further were corroborating this phenomenon. Moreover, the appearance of a peak at 2.79 ppm in Mo^{+6} and VO^{+4} complexes indicated the coordination of H_2O molecules through interaction with in the metal ions.

Conductivity measurements

The molar conductance of complexes in approximately 10^{-3} M concentration of DMF was measured at a temperature of 27 ± 20°C using the Systronic 303 direct reading conductivity bridge. A predetermined quantity of solid complexes was transferred into a 25 ml standard flask and dissolved in dimethylformamide. The solution was then diluted with

DMF to reach the flask's specified volume. Pour the solution of the complex into a 100 ml beaker that has been cleaned and dried. The molar conductance measurements of the complexes turned out to be below 20 Ohm^{-1} cm^2 mol^{-1}, which indicates their non-electrolytic characteristics. These recorded values strongly imply that the current set of complexes is indeed non-electrolytic in nature. You can find the molar conductance values of these metal complexes listed in Table 4.

UV-VIS. Analysis

A comparison of the electronic spectra of HL and M$_1$L, M$_2$L compounds in aqueous solutions has been documented in recent studies. The electronic spectrum of both the HL and its M$_1$L, M$_2$L metal complexes was made evident, and the associated transition was meticulously cataloged in Table 5. Specifically, the ligand electronic spectrum featured a distinct signal band peak appear at 278 nm, a manifestation of the π-π* transitions. Additionally, in the higher concentration spectrum of the complexation, the transitions of d-d surfaced within the visible region. In essence, this analysis of electronic spectra offers profound insights into the electronic energy landscapes of the ligand and its metal complexes. The observed shifts, the appearance of new bands, and the manifestation of d-d transitions collectively contribute to a comprehensive understanding of how complexation impacts electronic behaviors, thus enriching our comprehension of these compounds' responses to UV-Visible radiation.

ESR spectral studies

The Electronic spin resonances spectrum of the complexes in its polycrystalline state exhibited a singular broad peak signal, attribute to dipolar broaded and the enhancement of spin lattice relaxations. Anisotropic spectrum were obtain for this complex in dimethylformamide at Low Nitrogen Temperature, and represented Electronic spin resonances spectrum of M$_2$L complex was presenting in Figure 7. Within this low temperature spectra, three peak of minor intensities has been discerned, they are believed to emanate formed the $g^{\parallel}$ components. Spin hamiltonian, along with bonding parameters and orbital's reduction of the M$_2$L complexes, has been exhaustively present in the Table 6. The calculation of $g^{\parallel}$ and $g^{\perp}$ values utilized the free radical of DPPH a g marker. A seminal observation by Kvelson & Neiman [23] suggests that a given value below 2.3 indicates covalent character, while a value exceeding 2.3000 signifies ionic charactered in M-L bonds within complex. By applied these criterion, it can be inferred that covalent bonding characterizes the metal-ligand interactions in these complex [24]. Observed trend of $g^{\parallel} > g^{ave} > g^{\perp} > 2.0023$ for the complexes strongly suggests that the unpair electrons was localized in the dx^2-dy^2 and dz^2 orbitals of the VO^{+4} ion within the complexes. Additionally, the G value for these complexes exceeding four implies the absence of interaction between M-M center in a dimethylformamide media. Furthermore, Electronic spin resonances parameter, including $g\parallel$, $g^{\perp}$, $A^{\parallel*}$, and $A^{\perp*}$, as well as the energy of d-d transition, were employed to evaluated bonding parameter (α^2), orbital's reduction parameter ($K^{\parallel}$, $K^{\perp}$), and dipolar interactions (P) [25]. Remarkably, the observation of $K^{\parallel} < K^{\perp}$ implies the presences of out of plane π-bonding. Notably, the α^2 value for the presented chelate fall within the ranges of 0.420-0.482, providing strong supported for the covalence nature of this complex. Building upon Bereman's and Giordano insights, the identificated of bonding group from dipolar term P value was proposed. The reduction parameter of P value from the ion values (0.0360 cm^{-1}) is indicative of robust covalence bond. The P value obtained for the present complex, ranging from 0.0290 to 0.0360 cm^{-1}, consistently align with in the bonded of metal ion to O and N donor atoms. The collective analysis of Electronic spin resonances line shapes, Electronic spin resonances data, and electronic spectral data converges to suggest a square planar for M$_2$L complex [26].

Magnetic moment measurements

Table 7 displays the magnetic value for the complexes. Remarkably, these values reflect substantial contributions from orbital effects and magnetic susceptibility, particularly for the octahedral structure complex at RT. In the case of the M$_1$L complexes, the magnetic moment measures 5.12 B.M. Notably, this values is lower the spin only values, indicative of paramagnetism reduced. This observation strongly implies the formed of a low spin complexes characterized by an octahedral geometry. Equally significant, the M$_2$L complex exhibits a magnetic moment of 5.27 B.M. Once again, these value falls below the spin only values, underscoring paramagnetism reduced. In this instance,

the diminished magnetic moment provides compelling evidence for the formed of a low spin complex with a square planar geometry.

Thermal Studies

The thermo analytical data for the metal complexes has been comprehensively detailed in Table 8, while the corresponding thermo grams are visually represented in Figures 8 and 9. Notably, the M_1L complexes exhibit impressive thermal stability, remaining intact up to 815°C. The initial decomposition stage is characterized by the endothermic dehydrated of the metal complex, accompanied by the loss of two H_2O molecules within range of the temperature of 82-212°C. This process leads to the formed of anhydrous complexes [28]. The 2nd decomposition stage, featuring 2 endothermic processes, occurs around 480°C, forming a stable intermediate [29-30]. An exothermic decomposition step follows, resulting in the generation of the respective metal oxide as the decomposition final product at temperatures exceeding 595°C. It is important to note that these decomposition behaviors were observed under a nitrogen atmosphere. The experimental mass loss data corresponding to each stage are meticulously documented in Table 8. Similarly, the complexes display considerable thermal stability, maintaining their structural integrity up to 840°C. The initial decomposition stage involves the dehydrate exothermic of these metal complexes, leading to the loss of two H_2O molecule within range of the temperature 82-324°C, ultimately yield complex. The subsequent second decomposition stage, characterized by two exothermic processes, occurs around 450°C, result in the formed of a stabled intermediate phase. The ultimate exothermic decomposition process produces the respective M-O as the decomposition of the final product at temperatures surpassing 695°C. As with the Mo complexes, these thermal behaviors were observed under a nitrogen atmosphere, and the associated mass loss data for each stage can be found in the Table 8. Notably, at elevated temperatureded, the corresponded M-O are forming as stable end product. The experiment percentages mass losses were further comparing against calculated weights. The analysis of thermal data reveals a stability order among the complexes, with M_1L complexes exhibiting greater stability than M_2L complexes.

Biological Activity

In this present research, the primary objective of the author was to investigate the potential antibacterial studies of both the HL and M_1L, M_2L corresponding complexes. The selected bacterial strains for this investigation were *S. typhi, E. faecalis,* and *E. coli.* The method used is paper disc, as outlined in Table 9, was employed to assess the biological activity of these compounds. The outcomes of the biological testing of the metal complexes revealed several important insights. A comparative analysis between the free HL and M_1L, M_2L respective metal chelates clearly demonstrated that the metal chelates exhibit notably more antibacterial studies in comparison to the uncomplexed ligand. This electron delocalization led to an increase in the lipophilicity of the complexes, as cited in reference [31]. This heightened lipophilicity, in turn, facilitated the penetrated of the complex into lipid membranes, ultimately obstructing the metal chelate sites on the enzymes within the microorganisms. The assessment of antibacterial studies were quantified by measured the size of the zone of inhibition in millimeters. Upon comparing these results, it was evident that the Mo^{+6} and VO^{+4} Complexes of Schiff exhibited more substantial antibacterial activity when compared to the corresponding ligand. This finding suggests that these metal complexes possess potential as antibacterial agents, demonstrating their effectiveness against the selected bacterial strains.

CONCLUSIONS

The study synthesized Mo^{+6} and VO^{+4} complexes of N'-(2-hydroxy-3-methoxybenzylidene) benzohydrazide (HL). Spectroscopic analyses described the ligand HL and its complexes M_1L and M_2L. IR spectra indicated ligand (C=N) stretching shifting from 1643 cm^{-1} to 1622 cm^{-1} and 1637 cm^{-1} for Mo and VO complexes. ^1H NMR shifts were observed at 2.38 ppm for HL, 2.36ppm for M_1L, and 2.34 ppm for M_2L. Ligand transitions at 268 nm and 278 nm shifted to 382 nm for M_1L complexes, and 408 nm for M_2L complexes. Complexes thermal stability was assessed at 293-1173 K, with water molecules dehydrating and forming anhydrous substances that degraded into metal oxides.

Molar conductance measurements in DMF confirmed non-electrolytic nature. ESR spectra of VO^{+4} complex pointed to an octahedral geometry, with axial symmetry $g\parallel > g\perp > 2.0023$. Antibacterial testing on three bacterial strains revealed ligand HL best against E. coli, complex M_1L best against *E. faecalis*, and complex M_2L most effective against *E. coli*.

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Table 1: Physical and Analytical data of the HL and M_1L, M_2L complexes.

			Complex		
			HL	**M_1L**	**M_2L**
Molecular weight			284.329	697.939	652.939
Co lour			Pale Yellow	Orange	Pale Green
Yield			80	71	74
M.P			182-184	256-258	294-296
Elemental Analysis	C %	Calculated	67.50	55.11	55.84
		Found	67.47	55.42	55.45
	H%	Calculated	5.72	4.88	5.19
		Found	5.82	5.06	5.28
	N %	Calculated	9.71	8.01	8.54
		Found	9.69	7.83	8.22
	O%	Calculated	16.76	18.29	19.59
		Found	16.42	18.12	19.64
	M%	Calculated	-	7.83	13.71
		Found	-	7.79	13.75

Table 2: The important FT-IR bands of the HL and M_1L, M_2L Complexes

Compound	OH(Water)	υ_{OH} (Phenolic)	$\upsilon_{C=N}$	υ_{Ar-H}	υ_{M-O}	υ_{M-N}	υ_{C-H}
HL	-	3558	1643	3068	-	-	2844
M_1L	3348	-	1622	3026	456	822	2841
M_2L	3418	-	1637	3028	448	752	2840

Table 3: H^1 NMR Spectrum of the HL and its M_1L, M_2L complexes in DMSO-d_6 in ppm

Compound	H-C=N	CH_3	OH	OCH_3	Ar-H	O=C-NH
HL	2.38	1.19	11.50	3.8358	7.25	7.77
M_1L	2.36	1.18	-	3.6357	7.27	7.75
M_2L	2.34	1.16	-	3.5528	7.28	7.72

Table 4: Conductance data for M_1L and M_2L Complexes: Cell constant: 1.00

Metal Complexes	Conductance (Ohm^{-1})	Specific Conductance (Ohm^{-1} cm^{-1})	Molar Conductance (Ohm^{-1} cm^2 mol^{-1})
M_1L	0.00512×10^{-3}	0.00512×10^{-3}	5.12
M_2L	0.00527×10^{-3}	0.00527×10^{-3}	5.27

Table 5: UV-Visiable spectral data of the HL and M_1L, M_2L complexes

Complexes	λ_{max} of the complex in nm	λ_{max} of the ligand in nm
M_1L	382	278
M_2L	408	278

Table 6: ESR Spectra of Spin Hamiltonian and orbital reduction parameters of M_2L complexes in DMF solution

Parameters	M_2L
$g_\parallel$	2.0465
$g_\perp$	1.9800
g_{ave}	2.0071
G	3.7201
$A_\parallel$ *	0.0179
$A_\perp$*	0.0024
A_{ave} *	0.0079
d-d	13499
$K_\parallel$	0.8782
$K_\perp$	0.9911
P*	0.0359
α^2	0.4202

Table 7: Magnetic susceptibility of M_1L and M_2L complexes

Metal Complexes	Effect. In B.M.		Number of unpaired electron
	Theoretical	Observed	
M_1L	4.90	4.82	4
M_2L	1.68	1.79	1

Table 8: Thermal analytical data of the HL and M_1L, M_2L complexes

Complex X=H$_2$O	Molecular weight in gms	Weight of the complex take in mgs	Temperature Range during weight loss in ^{0}C	% of fraction of weight	Probable assignment
M_1L	697.940	8.1912	82-212 212-595 Above 595	5.1580 78.8033 9.5913	Loss of 2H$_2$O molecule. Loss of two HL molecules. Remaining residue Corresponds to MnO.
M_2L	652.942	12.1632	92-324 390-585 Above 585	5.5135 84.2341 17.1439	Loss of 2H$_2$O molecule. Loss of two HL molecules. Remaining residue Corresponds to VOO.

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Table 9: Biological studies of the HL and M₁L, M₂L complexes, zone of clearance in mm

Compound	*S. Typhi*	*E. Faecalis*	*E. coli*
HL	12	14	15
M₁L	17	19	18
M₂L	16	18	19
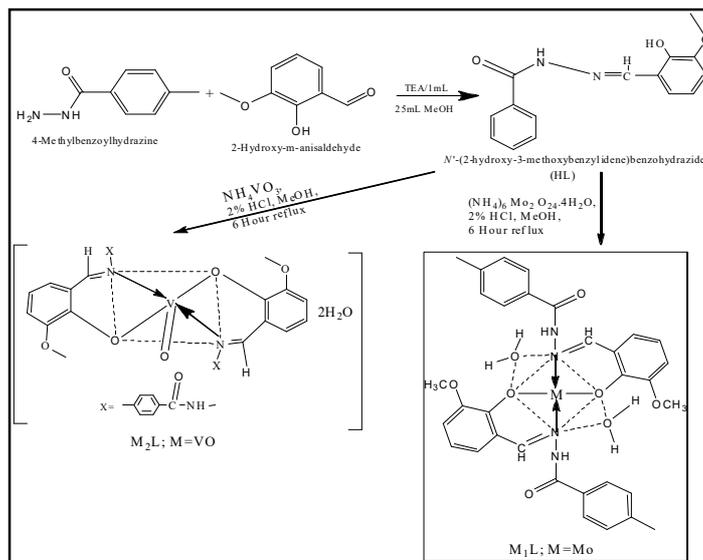
Scheme 1: Schematic representation of synthesis of Schiff base (HL) and its (M₁L&M₂L) metal complexes.
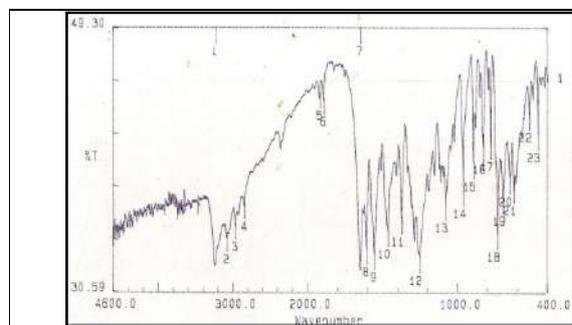
Figure1: FT-IR Spectrum of HL.	**Figure 2: FT-IR Spectrum of M₁L.**
Figure 3: FT-IR spectrum of M₂L.	**Figure 4: H¹NMR Spectrum of HL.**
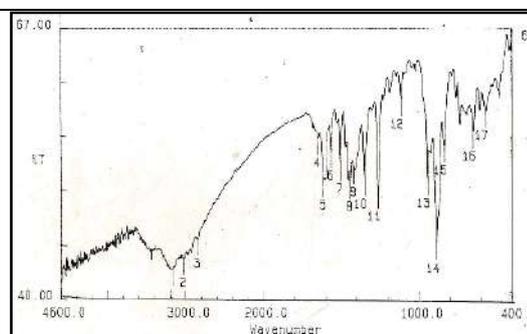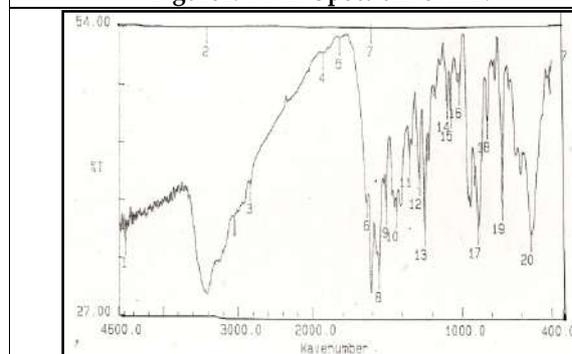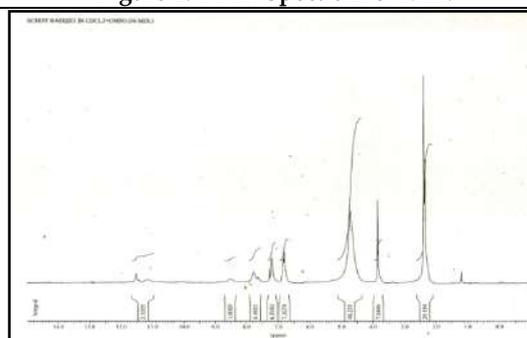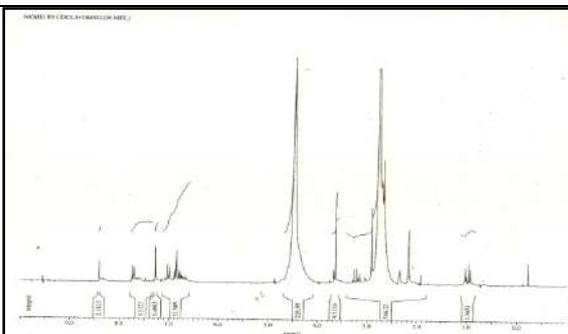
Figure 5: H¹NMR Spectrum of M₁L.
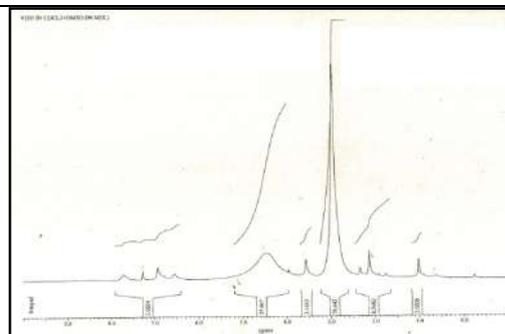
Figure 6: H¹NMR Spectrum of M₂L.
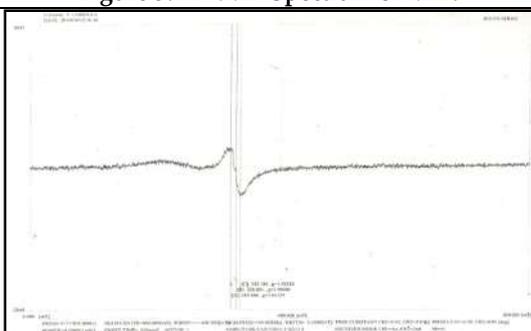
Figure 7: ESR Spectrum of M₂L.
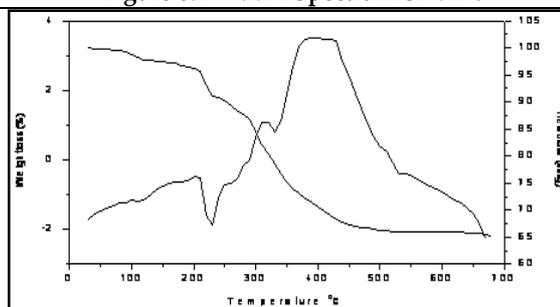
Figure 8: TG & DTA Spectrum of M₁L
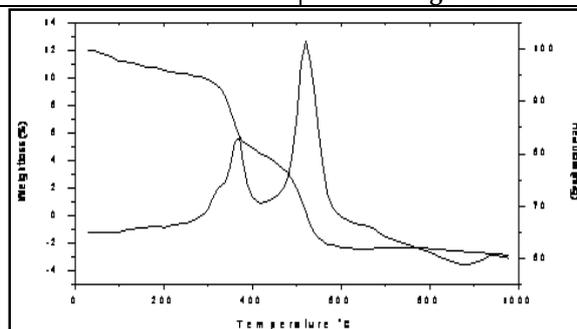
Figure 9: TG & DTA spectrum of M₂L.

RESEARCH ARTICLE

On graphs with Equal Strong Triple Connected Dominator Chromatic Number and Strong Triple Connected Domination Numbers

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ABSTRACT

Let $G(V,E)$ be a graph. A $S \subseteq V$ is called a dominating set of G if every vertex in $V-S$ is adjacent to atleast one vertex in S. The domination number $\gamma(G)$ is the minimum cardinality taken over all such dominating sets in G. A $S \subseteq V$ is a dominating set and the induced subgraph $\langle S \rangle$ is triple connected, then a subset of a nontrivial graph G is said to be a triple connected dominating set. The minimum cardinality taken over all three connected dominating sets is called the triple connected dominating number and is denoted by $\gamma_{tc}(G)$. Similarly the minimum cardinality taken over all strongly triple connected dominating sets is called strong triply connected dominating number and is denoted by $\gamma_{stc}(G)$. A strong triple connected dominator color of a graph G is a perfect triple color in which every vertex dominates every vertex of at least one color class. The minimum number of colors required for a strong triple connected dominator coloring of G is called the strong triple connected dominator chromatic number of G and is denoted by $\chi_{stc}(G)$. In this paper, we obtain bounds for general graphs and characterize the corresponding extremal graphs.

Keywords: Domination number, triple connected graph, strong triple connected domination number, strong triple connected dominator chromatic number (stc).

INTRODUCTION

Let $G(V, E)$ be a graph, where V and E the vertex and edge set of G. Denote $V = p$ and $E = q$, refer to [1] and [2]. The topic of the coloring and dominating set can be referred to [3,4]. The concept of dominator coloring was studied in [5]. In the modern world today, the concepts of three connected graphs with real-life applications have been introduced in [6]. A strong domination number $\gamma_{st}(G)$ is defined as the minimum cardinality of a strong domination set. In [7] one can find a comprehensive survey of the results of different types of dominating number of a graph.

Theorem 1.1 [5] Let G be a connected graph of order p. Then $\chi_d(G) = p$ iff G is the complete graph K_p.

Theorem 1.2 [6] A connected graph G is not triple connected iff there exists a $H -$ cut with $\omega(G - H) \geq 3$ such that $|V(H) \cap N(C_i)| = 1$ for at least three components C_1, C_2 and C_3 of $G - H$.

Theorem 1.3 [8] For any graph G, $\gamma_{nc}(G) \leq \left\lceil \dfrac{p}{2} \right\rceil$.

Theorem 1.4 [8] Let G be a graph with $\Delta < p - 1$. Then $\gamma_{nc}(G) \leq p - \Delta$.

Strong Triple Connected Dominator Chromatic Number
Definition 2.1
A strongly triple connected dominator coloring of a graph G is a perfect triple coloring of G in which every vertex dominates every vertex of atleast one color class. The minimum number of colors required for a strong triple connected dominator chromatic of G is called the strong triple connected dominator chromatic number of G and is denoted by $\chi_{stc}(G)$.

Example 2.2 For the graph in Figure 1.1, the strong triple connected dominator chromatic number of $\chi_{stc}(G) = 3$ and $S = \{v_1, v_2, v_3\}$ forms a $\gamma_{stc}(G)$ - sets. Hence $\gamma_{stc}(G) = 3$.

Observation 2.3 Strong triple connected dominator chromatic number does not exists for all graphs and if exists, then $\chi_{stc}(G) \geq 3$ and also the strong triple connected domination number of $\gamma_{stc}(G) \geq 3$.

Proposition 1 For any connected graph G, $\gamma(G) \leq \chi(G) \leq \chi_d(G) \leq \chi_{stc}(G) \leq \gamma_{tc}(G)$.

Theorem 2.1. If G is a strong triple connected graph with $\delta(G) = 3$ and k support vertices and support $\chi_{stc}(G) \geq k + 1$, and $\chi_{stc}(G) = k + 1$ iff the set of vertices without support is an independent dominating set of G.

Proof. Let S denote a set of supported vertices of G. Let $v \in S$. Then in any $\chi_{stc}(G) -$ the color v of the leaf v or close to it appears $\chi_{stc}(G) \geq k + 1$, so now $V - S$, if we form an independent dominant set G, $\{\{v\} : v \in S\} \cup \{V - S\}$ its dominant color is $\chi_{stc}(G) = k + 1$.

Conversely, suppose that $\chi_{stc}(G) = k + 1$. Let C be a $\chi_{stc}(G) -$ coloring of G, such that $\{v\}$ is a coloring class for every $v \in S$. So $V - S$ is a color class. In C and hence $V - S$ is an independent dominating set G.

Theorem 2.2 Let G be a strong triple connected complete graph with $\delta(G) = 3$. Then $\chi_{stc}(G) > \gamma_{stc}(G)$.

Proof. Let $\{v_1, v_2, \ldots, v_k\}$ is a $\chi_{stc}(G) -$ coloring of G, where every supported vertex is a triple coloring class and the set of all leaves of G is in a triple coloring class, say v_3. $S = \{v_1, v_2, \ldots, v_k\}$ where $v_i \in V_i$, $3 \le i \le k$. Clearly S contains all support vertices. We now say that S is a dominating set of G. Let $v \in V - S$ and V dominate the color class. If $i > 3, v_i$ is dominant. If $i = 3$, then v is a support vertex or leaf and is therefore dominated by S. Thus $\gamma_{stc}(G) \le |S| = \chi_{stc}(G) - 1$.

Theorem 2.3 Let T be a tree of strong triple connected order p. If T contains a $\gamma_{stc}(G)$ -set S such that $V - S$ is independent, then $\chi_{stc}(G) = \gamma_{stc}(G) + 1$.

Proof. From Theorem1.2 $\chi_{stc}(G) = \gamma_{stc}(G) + 1$. Let $S = \{v_1, v_2, \ldots, v_k\}$ as a $\gamma_{stc}(G)$-set in T such that $V - S$ is independent. Then $C = \{\{v_i\} : 1 \le i \le k\} \cup \{\{V - S\}\}$ is a $\chi_{stc}(G) -$ coloring of T, so $\chi_{stc}(G) = \gamma_{stc}(G) + 1$.

RESULT

For any graph G, $\gamma(G) \le \chi(G) \le \chi_d(G) \le \chi_{stc}(G) \le \gamma_{tc}(G)$.

Theorem 2.4 Let G be a strong triple connected graph G, $\chi_{stc}(G) + \gamma_{stc}(G) \le p + 1$ and the equality C_5 or K_p iff G is isomorphic, if $p \ge 4$ where $Y \subseteq E(G)$, $|Y| = p - 2$ and the edge-induced sub graph $\langle Y \rangle$ is a star.

Proof: If $\Delta < p - 1$; Then $\gamma_{stc}(G) \le p - \Delta$ and $\chi_{stc}(G) + \gamma_{stc}(G) \le p + 1$. Hence, $\chi_{stc}(G) + \gamma_{stc}(G) \le p + 1$, if $\Delta = p - 1$, then $\Delta = p - 2$; The inequality is obvious. If $\gamma_{stc}(G) = 3$; Then G is neither an odd cycle nor a complete graph. Therefore, $\chi_{stc}(G) + \gamma_{stc}(G) \le 2 + \Delta \le 2 + p - 1$. Now, suppose G is a graph with $\chi_{stc}(G) + \gamma_{stc}(G) = p + 1$.

Case (i): $\Delta = p - 1$

Then $\gamma_{stc}(G) \le 3$: if $\gamma_{stc}(G) = 2$; Then $\chi_{stc}(G) = p$ and hence G is isomorphic to K_p: Assume $\gamma_{stc}(G) = 3$: From Theorem 1.2 G has a vertex v with $\deg v = n - 1$ and v is a cut vertex of G: Since , $\chi_{stc}(G) = p - 1$; $G - v$ is G_1 and G_2 with two components $G_1 = K_1$ and $\langle V(G_2) \cup \{v\} \rangle = K_{p-1}$: Hence $G = K_p - Y$ where $Y \subseteq |E(G)|. |Y = p - 2|$ and the edge induced subgraph is a star.

Case (ii): $\Delta < p - 1$

Then $\gamma_{stc}(G) \le p - \Delta$. .But $\chi_{stc}(G) + \gamma_{stc}(G) = p + 1$; It follows that $\chi_{stc}(G) \ge \Delta + 2$ and hence, $\chi_{stc}(G) \ge \Delta + 1$: Hence G is an odd cycle and $\gamma_{stc}(G) \le p - \Delta = p - 2$: Hence $G = C_5$: The converse is obvious.

Theorem 2.5 For any connected graph G with $p > 3$, we have $3 \le \chi_{stc}(G), \gamma_{stc}(G) \le p - 1$ and the bounds are sharp.

Proof: The lower bound follows from Definition 2.1 and the upper bound follows from result 1. The lower limit is

reached at C_5 and the upper limit is reached at $K_{1,3}$.

Theorem 2.6 There is no cubic graph of order p with $\chi_{stc}(G) + \gamma_{stc}(G) = p$.

Proof: Let G be a cubic graph with $\chi_{stc}(G) + \gamma_{stc}(G) = p$. If G is a complete graph $\chi_{stc}(G) + \gamma_{stc}(G) = p + 1,$ then this is a contradiction. Hence $\chi_{stc}(G) \leq 3$. Then $\chi_{stc}(G) \geq p - 3$. It follows from Theorem 1.4, $\gamma_{stc}(G) \leq p - 3$. Thus we have $\gamma_{stc}(G) = 3$ and then $\chi_{stc}(G) = 3$. Theorem 1.3 gives $\gamma_{stc}(G) \leq \left\lceil \dfrac{p}{2} \right\rceil$ which implies $p \leq 9$. Since G is not a complete graph, we have $p = 6$. Then $\chi_{stc}(G) + \gamma_{stc}(G) = 3$. Each vertex v of G dominates four vertices, and since all vertices have degree 3, two vertices are sufficient to dominate eight vertices. Hence there is no cubic graph with $\chi_{stc}(G) + \gamma_{stc}(G) = p$.

Theorem 2.7 Let G be a connected graph with $p \geq 3$ vertices and has exactly one full vertex. Then $\gamma_{stc}(G) - 3$.

For, let v be an entire vertex in G. Then $S = \{v, v_i, v_j\}$ is the minimal strong triple connected dominating set of G such that v_i and v_j are in $N(v)$. So $\gamma_{stc}(G) = 3$.

Theorem 2.8 Any graph G with $p \geq 3$ vertices and exactly one vertex $\Delta(G) = p - 2, \gamma_{stc}(G) = 3$.

Proof Let G be a connected graph with $p \geq 3$ vertices and exactly one vertex has maximum degree $\Delta(G) = p - 2$. Let v be a vertex of maximum degree $(G) = p - 2$. Since G is connected, v_{p-1} is adjacent to a vertex v_i for some i. Then $S = \{v, v_i, v_{p-1}\}$ forms a minimal strongly three connected dominating set of G. So $\gamma_{stc}(G) = 3$.

Exact Value for Some Special Graphs

1) The Wagner graph is a 3-regular graph with 8 vertices and 12 edges, as shown in figure 1.3.

For the Wagner graph G, strong triple connected dominator chromatic number $\chi_{stc}(G) = 3$ and also $\gamma_{stc}(G) = 3$. Here $S = \{v_6, v_7, v_8\}$ is a minimum strong triple connected dominating set. $\gamma_{stc}(G) = 3$.

2) The Moser spindle is a 3-regular graph with 7 vertices and 11 edges, as shown in figure 1.4.

For any Moser spindle graph G, strong triple connected dominator chromatic number $\chi_{stc}(G) = 4$ and also $\gamma_{stc}(G) = 3$. Here $S = \{v_4, v_5, v_7\}$ is a minimum strong triple connected dominating set $\gamma_{stc}(G) = 3$.

3) The Petersen graph is a 3-regular graph with 10 vertices and 14 edges given in Figure 1.4 Figure 1.4

For any Petersen graph G, strong triple connected dominator chromatic number $\chi_{stc}(G) = 3$ and also $\gamma_{stc}(G) = 4$. Here $S = \{v_1, v_4, v_5, v_6\}$ is a minimum strong triple connected dominating set.

4) The Bull graph is a simple connected graph with 5 vertices, 5 edges, as shown in Figure 1.7.

For any Bull graph G, triple connected dominator chromatic number $\chi_{stc}(G) = 3$ and also $\gamma_{stc}(G) = 3$. Here $S = \{v_1, v_3, v_4\}$ is a minimum dominating set.

Relation with Other Graph Theoretical Parameters

Theorem 3.1 Let G be a strong triple connected graph of order $p \geq 4$. Then $4 \leq \chi(G) + \chi_{stc}(G) \leq 2p$. Further $\chi(G) + \chi_{stc}(G) = 8$ iff $G = K_4$ and $\chi(G) + \chi_{stc}(G) = 2p$ iff $G = K_p$.

Proof. Since $4 \leq \chi_{stc}(G) \leq p,$ the inequalities are trivial. Also $\chi(G) + \chi_{stc}(G) = 2p$ iff $\chi(G) = \chi_{stc}(G) = p,$ so it follows from Theorem 1.1 that $G = K_p$. Also $\chi(G) + \chi_{stc}(G) = 8$ if and only if $\chi(G) = \chi_{stc}(G) = 4,$ so it follows from Theorem 2.1 that $G = K_4$. The converse is obvious.

Theorem 3.2 Let G be a graph of order $p.$ Then $\chi_{stc}(G) = p$ iff $G = K_a \cup (p - a)K_1, 1 \leq a \leq p.$

Proof. Let $\chi_{stc}(G) = p$. Each element of G is clear. If G has two trivial elements G_1 and $G_2,$ then choose $u \in V(G_1)$ and $v \in V(G_2)$. Then $\{\{u, v\}\} \cup \{x\} : x \in V(G) - \{u, v\}\}$ is a dominant color of $G,$ which is a contradiction. Hence $G = K_a \cup (p - a)K_1,$ where $1 \leq a \leq p.$ The conversation is transparent. We now classify graphs with $\chi_{stc}(G) = p - 1.$

Theorem 3.3 Let G be a strong triple connected graph of order $p \geq 4$. Then $\chi(G) + \chi_{stc}(G) = 2p - 1$ iff $G = K_p - e.$

Proof. Let $\chi(G) + \chi_{stc}(G) = 2p - 1$. If $\chi(G) = p,$ then from Theorem 1.1, $G = K_p$ and $\chi_{stc}(G) = p,$ which is a contradiction. Hence $\chi_{stc}(G) = p$ and $\chi_{stc}(G) = p.$ Hence from Theorem 3.2 $G = K_5 \cup (p - 2)K_4,$ so $G = K_p - e.$ The conversation is transparent.

Theorem 3.4 For a connected G with $p \geq 4$ vertices, the connection is sharp iff $\gamma_{stc}(G) + \chi_{stc}(G) = 2p - 2$ and $G \cong K_4$.

Proof: Let G be a connected graph with $p \geq 4$ vertices. $K(G) \leq p - 1$ and by Theorem 2.5, $\gamma_{stc}(G) \leq p - 1$. Hence $\gamma_{stc}(G) + K(G) \leq 2p - 2$. Let G be isomorphic to $K_4,$ then clearly $\gamma_{stc}(G) + K(G) \leq 2p - 2$. Let $\gamma_{stc}(G) + K(G) \leq 2p - 2$. This is possible only if $\gamma_{stc}(G) = p - 1$ and $K(G) = p - 1$. But for $K(G) = p - 1,$ $G \cong K_p$ and for $K_p, p \geq 4,)$ $\gamma_{stc}(G) = 3.$ So $p = 4$. So $G \cong K_4$.

Theorem 3.5 For a connected G with $p \geq 4$ vertices, $\gamma_{stc}(G) + \Delta(G) \leq 2p - 2$ and the connection is sharp.

Proof: Let G be a connected graph with $p \geq 4$ vertices, $\Delta(G) \leq p - 1$ and by Theorem 2.5, $\gamma_{stc}(G) \leq p - 1$. Hence $\gamma_{stc}(G) + \Delta(G) \leq 2p - 2.$ For $K_4,$ the bound is sharp.

Theorem 3.6 For any connected graph G with $p \geq 4$ vertices, the bound is sharp iff $\gamma_{stc}(G) + \chi_{stc}(G) \leq 2p - 1$ and $G \cong K_4$.

Proof: Let G be a connected graph with $p \geq 4$ vertices. $\chi_{stc}(G) \leq p$ and by Theorem 2.5, $\gamma_{stc}(G) \leq p - 1$. Hence $\chi_{stc}(G) \leq 2p - 1$. Suppose G is isomorphic to $K_4,$ then clearly $\gamma_{stc}(G) + \chi_{stc}(G) \leq 2p - 1$. Let $\gamma_{stc}(G) + \chi_{stc}(G) \leq 2p - 1$. This is possible only if $\gamma_{stc}(G) = p - 1$ and $\chi_{stc}(G) = p$. Since $\chi_{stc}(G) = p,$ G is isomorphic to $K_p,$ for which $\gamma_{stc}(G) = 3$ for $p \geq 4$. Hence $p = 4$ and $G \cong K_4$.

CONCLUSION

In this paper, we find an upper bound for the sum of graphs with strong triple-connected chromatic number and strong triple dominance number, and classify the corresponding ones for some extremal graphs.

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Figure 1.1

Figure 1.3

Figure 1.4

Figure 1.4

Figure 1.5

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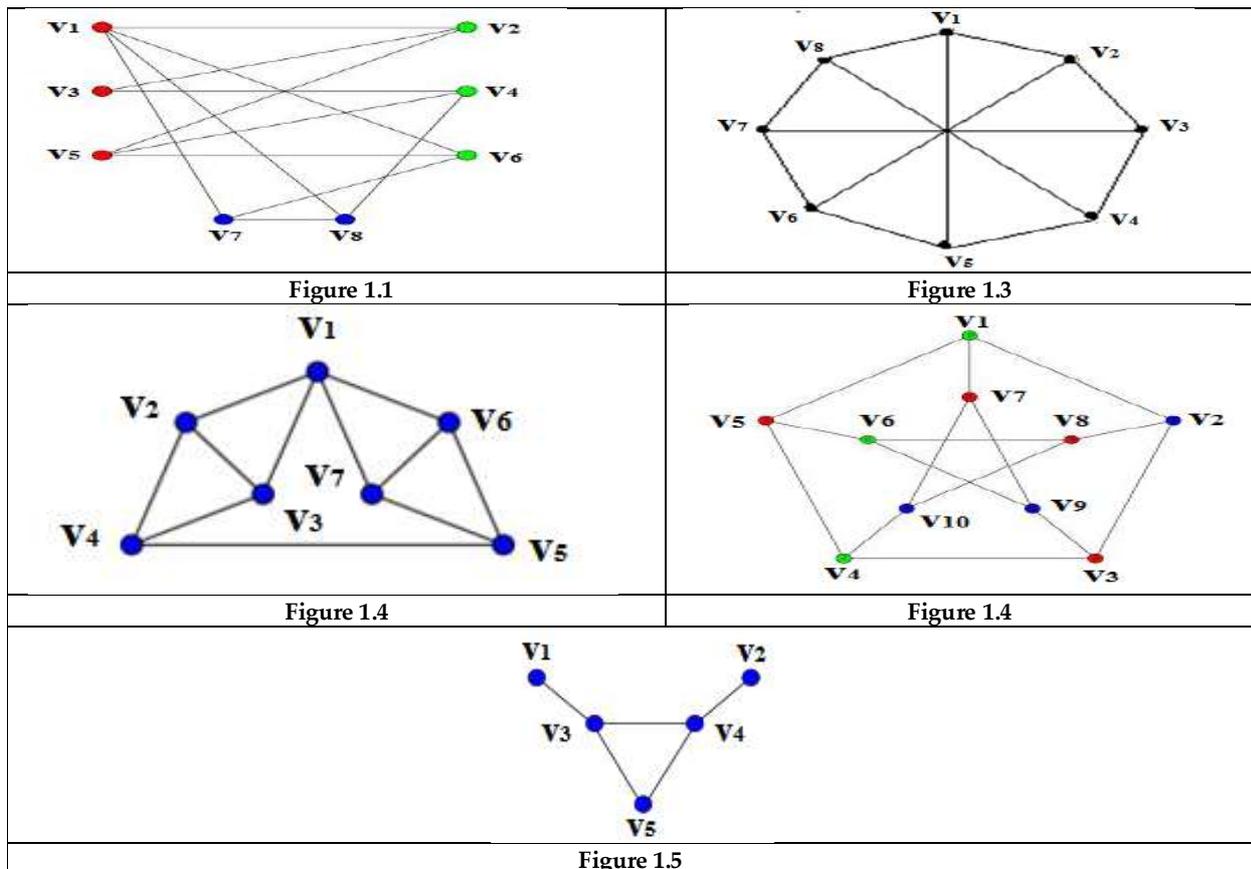
Recycling of Different Tea Powder Waste into Organic Compost and the Growth of *Vigna mungo* L.

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ABSTRACT

Proper management of solid waste is a major problem all over the world. Compositing is one of the oldest and simplest methods of organic waste stabilization. Composting tea waste is not only an environmental safe method of its disposal but also enhances the growth of the plants as it contain nutrients and tannic acid which creates a more fertile environment. Hence the present study was attempted to analyse the physicochemical parameters of the recycling compost were used. Then it was inoculated in the growth of *Vigna mungo*.L. Treatment was designed such as control (blank soil), composted tea waste and composted green tea powder waste and consortium of tea powder waste and green tea powder waste. The compost was prepared by using waste different tea powder with soil has increased concentration of essential nutrients needed for plant growth and development. The physico-chemical, microbial population and plant growth development parameters has increased by consortium treatment such as pH (7.79),temperature (8.02),electrical conductivity (4.09±0.09),nitrogen (6.53±0.03mg),phosphorus (0.65±0.02mg), potassium (0.86±0.07g), carbon (34.82±2.02g), height (45.3±1.45cm), number of leaves (39.1±1.20), shoot length (24.2±1.30cm),root length (13.5±0.34cm), number of roots (25.6± 0.92).The results indicated that soil treatment with consortium of different tea powder waste is better for PGPR activities of *Vigna mungo*.L

Uma Maheswari and Meena

INTRODUCTION

Tea powder is a great source of biodegradable garbage but it can also make a good source of compost as well. Proper management of solid waste is a major problem in most of the metropolitan areas. Composting is one of the oldest and simplest methods of organic waste stabilization. Composting tea waste is not only an environmental safe method of its disposal but also enhances the growth of the plants as it contains nutrients and tannic acid which create a more fertile environment. Tea powder can be a great source of biodegradable garbage but it can make good compost which usually discarded as wet garbage. According to (Diver,2002: Ingham,2005: Kannangara et al.,2006). Compost tea has been cited as an option for organic growers which enhance crop fertility by introducing microorganisms that might help in soil nutrient retention etc. Similar reports were confirmed by the (Pradeep and Narsimha et al.,2011,Radha et al., 2012).Tea powder can be great source of biodegradable garbage but it can make good compost which usually discarded as wet garbage. According to (Diver, 2002:Inham, 2005;Kannangara et al., 2006). Compost tea has been cited as an option for organic growers which enhance crop fertility by introduction microorganisms that might help in soil nutrient retention etc. similar reports were confirmed. (Pradeep and Narsimhaet al., 2011, Radhaet al., 2012). Tea waste is the residue that remains after tea leaves have been extracted by hot water to obtain water-soluble components. The waste contains a re-usable energy substrate and nutrients which may pollute the environment if they are not dealt with appropriately. Other agricultural wastes have been widely studied as substrates for cultivating mushrooms. In the present study, we cultivated oyster mushroom using tea waste as substrate (Doudou Yanget al., 2016).Tea dust and stalks and all the other little bits of waste can be easily processed and turned into liquids and bricks as biomass fuel, bio-char, and bio-oil. The waste is decomposed using fluidized bed pyrolysis, a thermal decomposition process that occurs in the absence of oxygen. Tea waste pyrolysis at high temperatures of 500-700°C and through gasification to produce bio-oil and bio char. The char can be converted into briquettes or mixed with biomass. This provides a highly efficient solid fuel for use in ovens and boilers across many industries including tea. The techniques can be fine-tuned to optimize the yield of char, liquid, and gas. Hence the present study was designed to recycling tea waste into compost and the effect on growth of *Vigno mungo*.L

MATERIALS AND METHODS

Collection of different tea powder waste sample
The tea powder waste was collected from the tea stalls and the hotels in and around Mannargudi, Thiruvarur district, Tamil Nadu, India. The tea powder waste was packed in polythene bags and brought to our laboratory. For the waste tea powder compost mixed equal amount of soil, cow dung and waste tea powder throughly and stored it in a cool place. The temperature and the moisture content of the compost were regularly checked and the temperature was maintained between 27-32°C for both the compost. After 2 months the compost was ready to use.

Compost preparation (Minakshiguravet al., 2013)
The piles were prepared by using combination of soil and tea waste in the ratio of 1:1. The Material was allowed to decompose for 30 days. The temperature was monitored regularly to check the process of completion of the decomposition. The temperature rises initially at 25°C and when the compost proceed best at a moisture content of 40% to 50% by weight, it remained constant. The compost is analyzed for physicochemical parameters.

Analysis of physicochemical parameters of the compost - before treatment (Jackson-1973)
Soil samples was collected from agricultural field in and around Mannargudi, Thiruvarur district. Tamil Nadu, India. After removing the debris, the soil samples was suspended in distilled water (1:2 w/v) and allowed to settle down the sand particles Physico-chemical parameters of soil such as pH, Temperature, Moisture content, Electrical

conductivity,Nitrogen. Phosphorous, Carbon, and Potassium content were assessed by electrometric and turbidity by standard method respectively, before inoculation with compost.

Determination of pH (Booth et al., 1961)
The resulting filtrate was measured for pH using a pH meter. Further, 25 ml aliquot was titrated to an end point pH of 8.1 with 0.01N solution of NaOH. Rearing sample was recorded by using the digital pH meter.

Determination of temperature (Aron, 1949)
Temperature probe and the data-collection interface were connected. The temperature probe was inserted into the soil to a depth of 10cm. When the temperature reading stabilized the displayed value was recorded (to the nearest 0.1°C) as the soil temperature at 10cm below the sample surface.

Determination of electrical conductivity (Black, 1978)
20 gram of sample was taken in a conical flask and it was stirred well with 40 ml of water and was allowed to strand for half an hour. The instrument was checked with 0.01N potassium chloride solution (E.C.2.2 Milli – mhos/cm -24.41 Milli mhos/cm) before proceeding with the sample. The electrode was washed in distilled water and then immersed in to a soil sample. The multiplier switch was set an intermediate position and the main dial control was rotated until the magic eye of the null indicator is at its widest. The reading of the scale at the position, multiplied by the value of the multiplier switch position which indicates the correct electrical conductivity.

Estimation of phosphorous (Olsen et al., 1973)
Five gram of dried sample was added with one teaspoon full of activated charcoal and 100ml of sodium bicarbonate. The flask was shaken for 30 minutes using rotator shaker. This solution was filtered through what man No. 40 filter paper by adding more charcoal to get clear solution. 5 ml of the extract was taken in 25ml volumetric carbonate flask and 5ml of solution were added. The flask was shaken gently to mix the contents for the rapid evoluation of carbon-dioxide.1ml of diluted dichloride was added and then it was up to 25ml with distilled water. The absorbance was read at 660 nm using spectrophotometer % Available phosphorous = $\frac{mg\ P/I\ of\ sample}{50}$

Estimation of carbon (Trivedi and Gel, 1986)
Oven dried sample was passed through 0.5mm sieve then 10 grams of the sample was added to 500 ml flask.10ml of 1N potassium dichromate and 20 ml of concentration sulphuric acid was mixed in it. Flask was then kept for 30 minutes for incubation. Then the contents were diluted to 200ml with distilled water.10 ml of phosphoric acid and 1ml of DPA indicator was added to the sample and then it was titrated against 0.5 N ferrous ammonium sulphate. End point was brilliant green.
% carbon = 3.951/ G × (1- T/S)
 G = Weight of sample
 S = ml of ferrous ammonium sulphate
 T = Titration reading in ml

Estimation of potassium (Black, 1965)
5 gram of dried, finely powered and sieved sample was treated with 25ml of ammonium acetate for 10 minutes with constant shaking. Then the soil solution was filtered using whatman No.40 filter paper and the filtrate was made upto 100ml with ammonium acetate.50ml of the solution was fed into the flame photometer and the solution was directly measured in ppm. Different concentration of standard solution was measured after the standarzation.
Sodium (mg/100mg)= $\frac{Mg\ N\ /V\ of\ soil\ extract\ \times V}{10\times S\times 23}$

Estimation Nitrogen (Subbaiah and Asija,1956)
20 gram of ground and sieved soil was taken in a distillation flask and it was added with 100ml of 0.32 % potassium permanganate, 100ml of 2.5% sodium hydroxide and 50ml of distilled water. Few drops of liquid paraffin were

added to avoid frothing. 10 mlof 2% boric acid was taken in 100ml conical flask and 3 drops of double indicator was added to it. The liberated ammonia was collected in the boric acid which was placed at the tip of the distillation set. It was titrated against N/10 sulphuric acid after 20 minutes of distillation.

Enumeration of microbial population in soil sample
Serial dilution (Ancja, 1996)
1gram of sample was suspended diluted water to make 10^{-1}dilution. 1ml sample was mixed with distilled water to make 10^{-2} dilution and this samples were serially diluted up is 10^{-9}dilution, 10^{-4}, 10^{-5}, and 10^{-7} dilution were selected. Then it was added over agar. The plates were incubated in a incubator at 37°C for 24-48 hours. After period of incubation, colonies were grown on petri plates. The isolated colonies formed on agar plates were identified using Gram staining and biochemical tests (Cappuccino and Sherman. 1999). The identification was performed according to Bergey's manual of bacteriology

Isolation and identification of bacteria(Han's Christian gram, 1884)
The colonies on the plates were subjected to staining method, in order to identify the morphology and Gram reaction of the bacterium. A thin smear was prepared on a clean slide using the isolated individual colony. The smear was heat fixed and cooled. The dried smear was then flooded with the primary stain, crystal violet and allowed to stand for 1 minute Thenit was washed with water and flooded with Gram iodine solution and allowed to stand for one minute. Then slide was washed with water and decolorized with 95% of ethanol, for few seconds and washed gently with running tap water. Then the slide was flooded with a counter stain, safranin for 1 minute. After drying, the stained smear was observed under microscope to identify the organisms.

Isolation and identification of fungi plating technique (Warcup, 1950)
Potato dextrose agar medium se prepared and sterilized at 121°C for 15 minutes. Then it was supplemented with streptomycin to prevent bacterial growth the medium was poured into sterile petri plates these serially diluted soil sample were directly inoculated into petri plates containing potato dextrose agar medium. The inoculated plates were incubated at 28-2 C for 3 days.

Pot trial experiment
1 kg of soil and 1kg of compost were filled in each pot in the ratio of 1:1

Seed treatment
Black gram seeds were soaked in water for overnight.

Design of treatment
Treatment1: Control (without any compost)
Treatment2: Tea powder waste compost with *Vigna mungo* .L
Treatment3: Green tea powder waste with *Vigna mungo* .L
Treatment4: Consortium of tea powder waste with *Vigna mungo* .L

Morphological parameters (Black , 1935)
After growth of plants, the morphological parameters were studied at the 15th, 30th and 45th days of growth. They are Height of the plant (cm), Root length (cm), Shoot length (cm), Number of leaves, Biomass, Number of roots, Number of branches, Number of fruits and Number of flowers. The biochemical contents such as Carbohydrate, Protein, Chlorophyll and Carotenoid were analysed by 45th day by standard procedure.

RESULTS AND DISCUSSION

In this present study, the tea waste were collected from different tea stall in mannargudi, Thiruvarur district, Tamil Nadu, India. The effectiveness of the growth of *Vigna mungo* was tested by using tea powder compost and control. The physicochemical parameters such as pH, Carbon, potassium Phosphorus, temperature, Biomass, Nitrogen and Electrical conductivity were tested before and after treatment. This study clearly showed that microbial degradation is eco-friendly and the most cost effective technique. The seed of *Vigna mungo* .L were transplanted in four pots of equal which were noted as treatment (T1)- control (uninoculated),(T2) –tea compost,(T3) – green tea compost and(T4) –constorium. The uninoculated pot was denoted as control. The morphological parameters such as leaves number, height, root length, shoot length, number of branches, number of flowers and number of fruits, number of roots and biochemical constituents such as chlorophyll, carbohydrates, proteins and carotenoids comment were analysed at different intervals (15th30th and 45th days) respectively. The results of this study revealed that the inoculation of Consortium (tea waste +green tea waste) for the cultivation of *Vigna mungo* L. Improvedall the growth parameters, carbohydrate, protein and chlorophyll content of the plant. It showed more effects on plant growth on combination with Consortium (tea compost + green tea compost). Day by day, the application of chemical fertilizers to the soil will make it sterile in the future i.e., making it inorganic and unfavourable for cultivation of crops. Thus to prevent environmental pollution and to reduce the extensive use of chemical fertilizers, the effective microorganisms can be recommended to the farmers to ensure public health and a sustainable agriculture. Steps have to be taken to introduce organic farming to the agrarians to achieve the goal of protecting the fertility of their cultivable lands. Use of fertilizers and organic manure in agriculture is becoming popular now a days, not only in order to minimize the cost of chemical fertilizer, but also reduce the adverse test of pesticides on soil and plant environment. Akhila Godishala -2019, Screening different microbial flora and their enzymatic activities during tea waste composting for the study was correlated to the finding of Analysis of soil with tea waste and cattle dung revealed that compost soil underwent changes in all measured physicochemical, biological and enzymatic parameters like moisture content recorded as 1.6 %, highest temperature as 46 ° C and percentage of microbial population like bacteria as 60 % and fungi as 40 % were observed in the compost soil. Higher enzyme activities such as protease, pectinase, xylanase were observed with bacterial isolates comparatively with fungal isolates. PGPR activities such as IAA, Siderophore production, phosphate solubilization and organic acid production were also observed. Improved soil microbial and enzyme activities in cattle dung soil is an indication of improvement in soil fertility. Therefore the produced compost can be used to increase the crop yield and simultaneously decreasing the environmental pollution.

CONCLUSION

The results of this study revealed that the inoculation of Consortium (tea waste +green tea waste) for the cultivation of *Vigna mungo* L. Improved all the growth parameters, carbohydrate, protein and chlorophyll content of the plant. It showed more effects on plant growth on combination with Consortium (tea compost + green tea compost). Day by day, the application of chemical fertilizers to the soil will make it sterile in the future i.e., making it inorganic and unfavourable for cultivation of crops. Thus to prevent environmental pollution and to reduce the extensive use of chemical fertilizers, the effective microorganisms can be recommended to the farmers to ensure public health and a sustainable agriculture. Steps have to be taken to introduce organic farming to the agrarians to achieve the goal of protecting the fertility of their cultivable lands.

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Table -1 :Morphological and biochemical characteristics of bacterial isolates

Biochemical test	Gram staining	shape	motility	MR	VP	citrate	urease	catalase
Bacillus sp	+ ve	Rod	Motile	+ ve	+ ve	-ve	-ve	+ ve
Pseudomona sp	-ve	Rod	Motile	-ve	-ve	+ ve	-ve	+ ve
*Streptomyce*s sp	+ve	Cocci	Non motile	-ve	-ve	+ ve	+ ve	+ ve
Streptomyces sp	+ve	Cocci	Non motile	-ve	-ve	+ ve	+ ve	+ ve
Azotobacte sp	+ve	Rod	Non motile	+ ve	-ve	+ ve	+ ve	+ ve

(+) –Positive, (-) –Negative

Table 2: Physico-chemical parameters of soil sample

Physico chemical parameters	Before treatment	After treatment
pH	6.2	6.7
Temperature	7.4	8
Moisture	60	65

Electrical conductivity	1.20-1.80	1.26-1.36
Nitrogen (mg)	86.4	90.6
Phosphorus(mg)	79.2	88.4
Potassium(g)	35	44
Carbon(g)	0.78	0.99

Table. 3: Effect of Compost on Different Morphological Parameters in *Vigno mungo*.L (45th day)

Treatments	Height of the plant (cm)	Number of leaves/plant	Shoot length (cm)	Root length (cm)	Number of roots/plant
T1	32.2 ± 0.35	28.0 ± 0.19	17.1 ± 0.27	5.5 ± 0.23	17.2 ± 0.55
T2	40.0 ± 1.40	38.3 ± 1.17	21.3 ± 1.27	10.1 ± 0.28	21.1 ± 0.85
T3	36.7 ± 1.30	33.7 ± 1.14	19.3 ± 1.25	7.2 ± 0.26	18.6 ± 0.78

RESEARCH ARTICLE

Digital Competence among School Teachers in Nagaland State: Differences with Reference to Gender and Age

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ABSTRACT

The purpose of this study is to examine the Digital Competence among the school teachers in Nagaland State with reference to gender and age. Total 400 teachers participated in the study. The sampling method of study is Multi Stage Random Sampling. The Digital Competence Scale for Teachers (DCST) developed by Ram krishna (2017) was used as a data collection tool in the study. According to the results, the variables of gender, and age in digital competence among school teachers were shown significant. It was determined that there was a significant difference in digital competence between Male and Female, different age groups of school teachers in Nagaland.

Keywords: Digital Competence, School Teachers, Gender, and Age

INTRODUCTION

Era in which we live is known and referred as digital age. In this age technology is rapidly changed and developed. In light of these technological advances in 21ˢᵗ century, schools have the responsibility of training "digital citizen" as well as a good citizen. (Isman & Gungoren, 2014). As stated by Prensky, (2001) education is one of the largest problems facing by digital world because our educators are digital immigrants whereas our students are digital natives; this digital generation gap has created a digital divide between teachers and learners. The teachers are struggling to teach a generation that has an increased exposure to technology, which has altered their thinking style, way of working along with the way of interaction and responding to digital devices. Therefore, to meet the specific learning needs of this generation, teachers need to acquire skills and abilities to integrate technology not only in the classroom but also in their routine life. Digital competence consists of various skills and competence; it has a wide

scope and covers technology, computing, literacy, media, information and communication. The European Parliament and the Council (2006) has broadly defined it as "Digital competence involves the confident and critical use of Information Society Technology (IST) for work, leisure and communication. It is underpinned by basic skills in ICT: the use of computers to retrieve, assess, store, produce, present and exchange information, and to communicate and participate in collaborative networks via the Internet." Digital competence has been acknowledged among the 8 key competences required for lifelong learning by the European Union. The Digital Agenda for Europe 2020 Council, (2006) confirms that digital competence is one of the key competences that are essential for individuals in knowledge-based society. It further emphasizes to educate their citizens to use ICT and digital media making it essential especially to attract young people towards ICT.

Arun & Jirli, (2021) conducted a study to understand the perception and effectiveness of Digitized Educational Efforts (DEE) by the female students of Banaras Hindu University. The study concluded that the majority of the respondent's perceived Digitized Educational Efforts as easily accessible and affordable than that of the traditional education system. According to Shokeen & Kaur, (2022) study has been conducted by reviewing empirical findings, which are focused on the utilisation of digital tools in teaching pre-service teachers. The reviews that are included revealed that there is a dire need of exposing the pre-service teachers to the digital world. Results of analyses revealed that attitude & self-efficacy, required skills & knowledge, practical experiences of using technology and access to technology are the factors that majorly influence pre-service teachers' digital competence. Verma & Verma, (2022) also investigated a study which aims to collect data from students and educators of both schools and colleges from rural and urban regions to identify the digital technologies widely used. From the study, we can conclude that this enforcement of digitalisation in the educational field will yield a fruitful future if the practical challenges are reduced. This will help students and educators to be prepared for the future when the majority of the task will be based on new technological models.

Objectives of the study
1) To study the difference of digital competence scores among school teachers with respect to Gender.
2) To study the difference of digital competence scores among school teachers with respect to Different Age Groups.

Hypotheses of the Study
1. There is no significant difference between male and female school teachers towards digital competence scores.
2. There is no significant difference in digital competence scores among school teachers with reference to Different Age Groups.

METHODOLOGY

 For the present study Descriptive method was used. The sample group of the research consisted of a total of 400 teachers, (128 male and 272 female) selected by using Multi Stage Random Sampling Method. Digital Competence Scale for Teachers (DCST**),** which was developed and standardized by Ramkrishna (2017) was adopted and used by the researchers to determine the difference in digital competence with regard to gender, age. The scale consisted of 50 items and the major factors included in this scale are: A. Knowledge of Digital Practices, B. Expertise in Using Digital technology for teaching learning, C. Evaluating and Authorizing Online information, D. Managing and Communicating Digital Data, E. Collaborating and Sharing Digital Data for Teaching Learning. The investigators personally met the school teachers and asked them to volunteer themselves to participate in the study conducted. Each of them was given sufficient time to reflect on the question while answering them so that they could understand each and every question properly before they answer them. After collecting the data, tabulation of the information according to the objectives and subsequent evaluation of the data was done.In this context, in the analysis of the data; independent t-Test, ANOVA were used.

Yangermenla Jamir and Rajendra Nath Babu

DATA ANALYSIS AND INTERPRETATION

Digital Competence and Gender

From Table No- 1, overall data shows the mean scores of digital competences of male teachers is 202.41 and the mean scores of female teachers is 194.58. The standard deviation (SD) of male school teachers is 29.180 and that of female school teachers is 27.516. This indicates the difference of mean score of 7.83 which is in favour of male teachers and shows that male school teachers have higher digital competence than the female teachers. In order to find out the difference between male and female school teachers towards digital competence scores, a null hypothesis was formulated as follows- There is no significant difference between male and female school teachers towards digital competence scores. From table No-1 it also shows that the computed t-value is 2.601 is higher than the table value (1.96) at 0.05 level of significance with 398 df. This indicates that there is a significant difference of digital competence between the mean scores of male school teachers and female school teachers. Thus, the null hypothesis, "there is no significant difference between male and female school teachers towards digital competence scores "is not accepted. Hence the results show that male school teachers have higher digital competence as compared to female school teachers. The reason may be because of their interest mostly males are more inclined towards technology and that this fascinates them to be more digital literate than the females.

Digital Competence and different age groups

In Table No-2, overall data shows the mean scores of digital competence of different age groups such as below 25 years mean scores is 205.00, age group 26 years to 30 years is 206.06, 31 years to 35 years is 197.31 and 36 years and above age group mean scores is 191.74. This data shows that 26 years to 30 years age group school teachers have higher digital competence among the other age group. In order to find out the difference between digital competence scores among school teachers with reference to different age groups, a null hypothesis was formulated as follows- "there is no significant difference in digital competence scores among school teachers with reference to different age groups". The Table No-3 shows that the calculated value of F is 5.658 which is greater than the table value of 2.62 at 0.05 level of significance with (3,396) df and hence we do not accept the null hypothesis, "there is no significant difference in digital competence scores among school teachers with reference to different age groups". We may therefore, conclude that the different age groups of school teachers have significant difference to digital competence. Therefore, the study revealed that the teachers between the age group 26 years to 30 years showed higher Digital Competence which may be because this age group consist of young and fresh graduates who are mostly internet savvy than those school teachers who are older adults.

DISCUSSION, CONCLUSION, AND SUGGESTIONS

Discussion and Conclusion

In the study, Digital Competence among School Teachers was investigated with reference to gender, age. Under this title, it was supported by the literature, in line with the findings obtained from the study. According to the results the mean scores of digital competences of male teachers were more in comparison to female counterparts. In other words, it can be said that male school teachers had higher digital Competence to female. The studies in the literature on the study were examined. These findings agree with the findings of Pratap & Singh (2018), about the majority of the respondents were male. Previous study conducted by Silva et al. (2019) also justified that the male student teachers achieved a higher teachers digital competence level when compared with females. In contrary to these findings, results reported by Kuzminska et al. (2018) reveal that there was no defined significant difference on gender. With reference to variable with different age groups, it was found that the mean scores of the school teachers who fall under the age group 26 years to 30 years school teachers were higher than the mean scores of the school teachers in the other age group. In other words, it can be interpreted that school teachers of age group 26-30 years are more digitally competent. These finding is in contrary to Kuzminska et al. (2018) where the results show no significant difference with regard to age.

SUGGESTIONS

Considering the findings and results obtained as a result of the study carried out, the investigators has laid down some possible suggestion for further improvement to enhance the digital skills among the school teachers. After analysing and interpreting the results of the study, the investigators is forwarding the following points based on the findings with the hope that with this implementation, teaching-learning could become more lively and joyful. The present study provides some valuable inputs to the educational system and in the teaching learning process so far as the quality of teachers is concerned.

1**.** This finding may help the teachers and school headmasters/ principal of schools to be more conscious of their responsibilities and thereby improving their ICT facilities in the schools and classrooms. This may also help the administrators to facilitate more supportive and enriching training to the school teachers in order to improve their skills of handling digital tools.
2. The schools should provide adequate teacher training for the teachers in computer application courses such as diploma in software application in order to update with modern technological applications in the teaching learning process.
3. The smart teaching tools such as projectors should be installed in the classroom for effective teaching learning.
4. Computer application course should also be considered as one factor while recruiting the teachers in the school.
5. Teachers should improve their proficiency in handling digital technology and integrate digitalisation while teaching the content to make students more attentive and understand the subject matter more easily.
6. More often teachers should cultivate the urge to use online teaching so as to motivate and appreciate the importance of development of ICT in the teaching learning process.
7. Acquiring digital competence will not only be helpful for teachers but also it will empower them to guide their students more effectively for online learning and referencing for better academic success.

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Table 1: Mean Score, SD and t-value of Digital Competence Scores between Male and Female School Teachers

Variable and its Dimensions	Gender	N	Mean	Std. Deviation	t-Value
Knowledge of Digital Practices	Male	128	49.09	8.246	4.161*
	Female	272	45.56	7.731	
Expertise in Using Digital Technology for Teaching Learning	Male	128	48.88	7.411	1.346@
	Female	272	47.85	6.928	
Evaluating and Authorizing Online Information	Male	128	39.44	6.672	2.895*
	Female	272	37.51	5.995	
Managing and Communicating Digital Data	Male	128	31.89	4.779	2.040*
	Female	272	30.88	4.529	
Collaborating and Sharing Digital Data for Teaching Learning	Male	128	33.12	4.934	.594@
	Female	272	32.78	5.468	
Digital Competence score	**Male**	**128**	**202.41**	**29.180**	**2.601***
	Female	**272**	**194.58**	**27.516**	

Table 2: Mean score, SD of different age groups of school teachers with reference to digital competence scores

Variable and its Dimensions	Different age groups	N	Mean	S .D
Knowledge of Digital Practices	Below 25 Years	7	50.86	6.817
	26 Years to 30 Years	95	48.95	7.425
	31 Years to 35 Years	123	47.27	7.163
	36 Years and Above	175	44.89	8.637
Expertise in Using Digital Technology for Teaching Learning	Below 25 Years	7	48.57	6.451
	26 Years to 30 Years	95	50.85	6.853
	31 Years to 35 Years	123	48.46	6.030
	36 Years and Above	175	46.52	7.506
Evaluating and Authorizing Online Information	Below 25 Years	7	39.29	6.157
	26 Years to 30 Years	95	39.32	6.837
	31 Years to 35 Years	123	37.75	5.679
	36 Years and Above	175	37.70	6.328
Managing and Communicating Digital Data	Below 25 Years	7	32.86	4.562
	26 Years to 30 Years	95	32.47	4.708
	31 Years to 35 Years	123	31.14	4.395

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	36 Years and Above	175	30.50	4.625
Collaborating and Sharing Digital Data for Teaching Learning	Below 25 Years	7	33.43	3.910
	26 Years to 30 Years	95	34.47	7.128
	31 Years to 35 Years	123	32.70	4.443
	36 Years and Above	175	32.14	4.539
Digital Competence Score	Below 25 Years	7	205.00	26.827
	26 Years to 30 Years	95	206.06	29.355
	31 Years to 35 Years	123	197.31	24.696
	36 Years and Above	175	191.74	28.950

Table No-3: ANOVA Table

Variable and its Dimensions	Sum of squares	Mean of squares	F value
Knowledge of Digital Practices	Between Groups	404.294	6.481*
	Within Groups	62.380	
Expertise in Using Digital Technology for Teaching Learning	Between Groups	390.402	8.178*
	Within Groups	47.737	
Evaluating and Authorizing Online Information	Between Groups	64.553	1.647@
	Within Groups	39.202	
Managing and Communicating Digital Data	Between Groups	86.750	4.145*
	Within Groups	20.927	
Collaborating and Sharing Digital Data for Teaching Learning	Between Groups	114.654	4.181*
	Within Groups	27.424	
Digital Competence Score	**Between Groups**	**4365.543**	**5.658***
	Within Groups	**771.594**	

RESEARCH ARTICLE

Case Series on Chronic Rheumatic Heart Disease

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ABSTRACT

Repeated episodes of rheumatic fever (RF) lead to rheumatic heart disease (RHD) which is an autoimmune reaction caused by exposure to group A streptococcal infection (GAS) resulting in permanent damage to heart valves (valve stenosis, regurgitation) heart failure, malfunction of the left ventricle (LV), arrhythmias, and pulmonary hypertension. In the study period, we observed five cases with an age distribution of 21-70 years. Out of 5 cases, three patients have undergone surgical procedures of balloon mitral valvotomy, open mitral valvotomy, and double valve replacement. Patients between the ages of 21 and 30 years started penicillin therapy to reduce the progression of valvular damage. As there is no vaccine for Streptococcus. pyrogen infection awareness should be shared regarding RHD to reduce the incidence of the disease.

Keywords: Rheumatic fever, mitral regurgitation, streptococcus, penicillin, stenosis, pulmonary artery hypertension.

INTRODUCTION

Rheumatic heart disease (RHD) develops with repeated episodes of rheumatic fever(RF) which is an autoimmune reaction produced by group A streptococcal infection (GAS) results in permanent damage to heart valves[1].RHD is endemic in underdeveloped countries. In India, RHD prevalence was 1.5-2 in 1000 in all age groups [2]. RF is diagnosed using the updated Jones Criteria whereas RHD is diagnosed clinically and verified by echocardiography (ECG) or other imaging modalities [3]. The greatest method for preventing recurring RF assaults, which cause valvular disorders, is penicillin prophylaxis, however, most patients lacked symptoms until their conditions worsened [4].

Case-1

A 50-year-old woman with CHRD who had a double valve (aortic and mitral) replacement with anticoagulation therapy and hypertension (Tab. Metoprolol 50 mg) since 7 years presented to the emergency department with chief complaints of (c/o) palpitations, giddiness, and shortness of breath (SOB) for 4 days. Nicoumalone 2 mg was discontinued for 6 months due to epistaxis. She was afebrile, and hypotensive (inj. noradrenaline 4 cc plus normal saline 46 cc was continued for 2 days until BP was normal), with a pulse rate (PR) of 150 beats per minute (b/m) and an oxygen saturation level (SpO2) of 98% under room air, as well as bilateral pedal edema and hearing basal crepts.On laboratory investigations in Table 1 and on examination, this was confirmed as a cardiogenic shock. Nicoumalone 2 mg has been started after 5 days of admission by monitoring the prothrombin time (PT) [7 seconds] and following treatment in Table 2. The patient got stabilized after 7 days of hospitalisation and was advised not to stop anticoagulants.

Case-2

A 45-year-old woman with CRHD who underwent mitral valvotomy presented to the emergency department with c/o SOB for 15 days and progressed from grade 2 to 4 associated with orthopnoea and PND (post nocturnal dyspnoea), mild sub sternal and non-radiating chest pain, and pedal edema since 1 week. A patient has reported multiple admissions in hospitals for 10 years in view of SOB. She was normotensive, SpO2 was 92% under room air (with 4 litres of oxygen with the level of SpO2 96%), hearing of basal crepts and an MDM(mid-diastolic murmur) in the mitral area; PR of 134 b/min. Laboratory investigations are in Table 1. Medications have been prescribed to provide symptomatic relief in Table 2, meanwhile, with the advice of a cardiologist, Inj. Heparin 5000 IU QID and Tab. Warfarin 2 mg OD for 3 days with monitoring of PT [9 seconds] has been started. She gradually improved and was discharged to home after 8-day hospitalisation. Case-3: A 70-year-old man with CRHD for 20 years who have undergone balloon mitral valvotomy (BMV) was on irregular medication and admitted to the hospital with c/o SOB from grade 2 to 3 associated with orthopnea and PND, chest pain, and syncopal attacks. The patient was hypertensive (170/120 mmHg treated with Inj. Furosemide 40 mg OD), heard of paradoxical septal motion (PSM) in the tricuspid area, MDM, decreased air entry in the mammary area, inter scapular area, and infra-axillary area, PR was 93 b/min, and SpO2 was 94%. Following laboratory investigations in Table 1 and treatment in Table 2 have been suggested and got stabilised

Case-4

A 30-year-old man who was previously diagnosed as CRHD 5 months back was not on regular medication, chronic alcoholic came with C/O SOB from grade 2 to 4, abdominal distension, pedal edema, and decreased urine output associated with micturition. The complaining Patient was afebrile, hypotensive (Inj. Dobutamine 5cc in 95cc Normal saline for 4 days), SpO2 was 97%, and PR-92 b/min and jugular venous pulse (positive). Up on laboratory investigations in the table-1 patient was diagnosed with acute kidney injury with acute liver injury and thrombocytopenia. A patient got stabilised after 15 days of hospitalisation by advising following treatment in table-2 and penicillin therapy have been started after 5 days of admission

Case-5

A 21-year-old female patient (G2P1C 28 weeks) was referred from another hospital in view of CRHD with moderate anemia and complicated Pregnancy and had no complaints of pain in the abdomen, bleeding pelvis, palpitations, chest pain, and shortness of breath. The menstrual history of the patient was regular (5/30), with 1-2 pads per day, with no clots and dysmenorrhea. She was hypotensive, PR- 85 b/min, heard of murmurs, GRBS-76 mg/dl. Fetal heart and movements were good, Spo2 was 90% and Haemoglobin (8g/dl) and PT were 15 seconds were supported by oxygen inhalation. Following laboratory investigations and treatments are in Table 1 and Table 2. With the advice of a cardiologist beta-blockers, diuretics, and Inj. Benzylpenicillin 1.2 million IU (once in 3 weeks) has been started. Gynaecologists took extremely good care because there could be a risk to the mother and the foetus.

DISCUSSION

Repeated RF episodes lead to RHD which causes valve stenosis, regurgitation, heart failure, malfunction of the left ventricle (LV), arrhythmias, and pulmonary hypertension (PHT) [5]. The Study on the gender differences in the epidemiology of RHD was undertaken by Negi PC et al. and observed a high prevalence of disease in both men and women between the ages of 40 and 49, with a mean age of 39 for men and 41 for women [6]. We collected five cases, out of which three were women and two were men with the ages of 50, 45,21(women) and 70, and 30 (men). The detection of RHD in an ECG study using morphological and Doppler-based techniques has a high sensitivity and specificity compared to auscultation-based screening methods [7]. Even though five patients were previously diagnosed with CRHD, physicians performed the ECG and 2D echo to observe the morphology of the valves. The mitral and aortic valves are the most frequently impacted by CRHD while the tricuspid valve and pulmonary valve are less frequently affected. Valve regurgitation and stenosis may occur in isolation or in combination [8]. We have observed in case 1 with AS, case 2 with severe MR and MS, trivial TR, case 3 with moderate AR and MR, severe TR and in case 4 with severe MS and MR, moderate AS and AR, and in case 5 with severe MS, moderate TR, mild AR. AF is more prevalent in patients with surgical valve replacement than in valvuloplasty [9]. Out of 5 cases, case 2 and case 3 have undergone valvotomy with AF whereas case 1 patient with double valve replacement(DVR)with no AF, and in cases 4 and 5 was recently diagnosed with no surgical procedures.PAH is one of the categories of PHT and is a common complication in RHD mostly observed in mitral and aortic valvular disease [10]. We have noticed that patients (cases 2 and 3) who have undergone mitral valvotomies have developed severe PAH and moderate PAH. Case 1 had a surgical procedure of DVR 6 years ago, Case 2 had open mitral valvotomy (OMV) performed 10 years ago, and Case 3 had OMV 3 years ago. For the medication-based management of CRHD diuretics for fluid overload, beta-blockers, and angiotensin blockade (angiotensin-converting enzyme inhibitors and angiotensin 2 receptor blockers) for LV dysfunction, to control heart rate in MS, rate and rhythm control in AF, and anticoagulation therapy to lower cardioembolic events and valve thrombosis are potential targets [11]. Following all drugs have been administered to all the patients cases 1-4) and in case 5, as she was pregnant angiotensin blockade must be avoided and treated with beta-blockers and diuretics. Digoxin is suggested in RHD with heart failure to improve cardiac output and relieves congestion [12]. Case 1 and case 2 were managed with digoxin therapy whereas in case 3 with sildenafil. For MS open or closed valvotomy or valve replacement is suggested whereas in MR valve replacement is beneficial to avoid long-term anticoagulation therapy and patients with MR and AR end up with valve replacement [13]. Consumption of alcohol may increase blood pressure and the increase of triglycerides in the blood results in a risk of stroke and congestive heart failure[14]. Even though the patient had only recently been identified, the condition of the patient in Case 4 who had a tendency of drinking alcohol worsened the condition and they eventually suffered acute decompensated heart failure. Administration of penicillin (IM) is prescribed as secondary prophylaxis to avoid recurrent attacks of RF. During our study we observed out of 5 patients, four patients were not on regular medication because of unawareness of their disease condition, and social, economic, and behavioural barriers resulted in the progression of the disease. To reduce morbidity and mortality, physicians and other healthcare providers must devote valuable time to educating patients about their condition.

CONCLUSION

This cases highlights the progression of valvular damage by discontinuing the medications prescribed for long term management to reduce morbidity and mortality. Lack of awareness regarding the disease condition is the prior cause for frequent hospitalisation. However, more research should be performed to detect at an early stage.

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Abbreviations

CRHD-Chronic Rheumatic Heart Disease, RF- Rheumatic fever, MR- Mitral Regurgitation, DDF- Diastolic Dysfunction, MS- Mitral Stenosis, PAH- Pulmonary Arterial Hypertension, TR- Tricuspid regurgitation, AF- Atrial fibrillation, PND- Post Nocturnal Dyspnoea, BMV-Ballon Mitral Valvotomy, AS- Aortic Stenosis, AR- Aortic Regurgitation

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Table-1: Laboratory Findings

	Case 1	Case 2	Case 3	Case 4	Case 5
2D echo	Left ventricular(LV) global hypokinesia, Severe LV systolic dysfunction, Grade-2 Diastolic	Moderate Mitral regurgitation(MR), Mitral stenosis (MS),Moderate Pulmonary arterial hypertension(PAH), Trivial tricuspid	Moderate aortic regurgitation(AR),Moderate MR, severe Mild LV systolic dysfunction, Severe PAH,LV global hyperkinesia	Dilated cardiac chamber, severe MS and MR, severe LV dysfunction,	Severe MS, Moderate TR And PAH, Mild AR

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				moderate AS and AR	
ECG	Sinus tachycardia	Irregular rhythm with premature ventricular complexes	Atrial fibrillation(AF) with rapid ventricular response, left ventricular hypertrophy (LVH)	Sinus tachycardia with LVH	Sinus Tachycardia, Slight ST-T Abnormality, right Axis deviation

Note: top partial row reads: dysfunction(DDF), aortic stenosis(AS) | regurgitation(TR), Good LV systolic function

Others

In case 4 Ultrasound scan of abdomen has shown moderate ascites and gall bladder oedema, elevated levels of urea-184, Creatinine-2.88, Total bilirubin-5.25 and Alkaline phosphate- 95.

Table-2: Pharmacological Treatment

Case-1	Case-2	Case-3	Case-4	Case-5
1.Tab. Furosemide 20mg OD (to reduce SOB), 2.Tab.Digoxin (To control sinus rhythm and heart rate) 0.5mg as starting dose followed by 0.125mg OD for 3 days and continued as Tab.Digoxin 0.25 mg OD 3.Tab.Metoprolol 50mg OD (left ventricular remodeling)	1.Inj.Furosemide 40mg BD for 3 days followed by Tab. Dytor plus 10mg OD (Spironolactone) 2.Tab.Metoprolol 25mg BD 3.Tab.Enalapril 2.5mg BD(for moderate and severe MS) 4. Tab.Digoxin 0.125mg OD	1.Inj.Augmenin1.2gm BD 2.Tab.Metoprolol 25mg BD 3.Inj.Furosemide 40mg BD 4.Tab.Aldactone25mg OD 5. Tab. Sildenafil 25mg BD(used for pulmonary hypertension with heart diseases) 6.Tab.Aspirin 75mg OD 7.Tab.Clopidogrel 75mg OD	1.Inj.Ceftriaxone 2gm BD 2.Inj.Dobutamine 5cc+45cc NS(prescribed for 5 days to treat hypotension) 3.Inj.Pantop 40mg OD 4.Inj.Ondansteron 4mg BD 5.Tab.Metoprolol12.5mg BD 6.T.Ursodeoxycholic acid 300mg BD 7.Tab.Sodiumbicarbonate 500mg BD 8.Inj.Furosemide 20mg BD 9.Inj.Paracetmol 1gm BD	1.Tab. Metoprolol 25 mg OD 2.Inj. Furosemide 20mg-20mg-

RESEARCH ARTICLE

A Study to Compare the Effectiveness of Mulligan with Movement with Eccentric Exercise and Cryotherapy Versus Myofascial Release Technique with Eccentric Exercise and Cryotherapy in Terms of Pain, Range of Motion and Grip Strength in Subjects with Lateral Elbow Tendinopathy

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ABSTRACT

This study is to evaluate the effectiveness of mulligan with movement with eccentric exercise and cryotherapy versus myofascial release technique in terms of pain, range of motion, grip strength in subjects with lateral elbow tendinopathy. Forty subjects, who fulfilled inclusive criteria, are randomly assigned as Group A (Mulligan with Movement with Eccentric Exercise with Cryotherapy) and the remaining 50% received Group B (MyofaScial Release Technique with Evolved Exercise and Cryotherapy). The sample of 40 subjects have been randomized into Group A and Group B in 1:1 ratio -

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that is, 50% of the subjects received Group A. The samples have been evaluated for Pain, Range of Motion, Grip Strength, and NPRS scores. There is significant increment in Radial deviation Range of motion Score, Ulnar deviation, Flexion Range of motion, Flexibility Range of motion and Flexion Range of motion scores after the treatment (Group A).We conclude that there is significant improvement in Pain, Gait Strength, Flexion Range of motion, and Grip strength after treatment with Mulligan

Keywords: Mulligan manual therapy, lateral epicondylitis, cryotherapy, grip strength.

INTRODUCTION

In 1976, a type of tendon degeneration named 'tendinosis' was first described in the Achilles tendon by Puddu et al [4]. Lateral epicondylagia, lateral epicondylosis, tennis elbow or lateral epicondylitis are inappropriate clinical diagnostic terms due to patho-physiological, anatomical and aetiological factors. Therefore, lateral elbow tendinopathy (LET) is the most appropriate clinical diagnostic term. LET is defined as a cause of pain in the lateral epicondyle that failed healing tendon response rather than inflammatory or may be degenerative. LET is characterized by absence of inflammatory cells, glycosaminoglycans and proteoglycans, disorganised and immature collagen vascular hyperplasia and the increased presence of fibroblasts [8]. It is generally attributed to osteotendinous irritation of the common extensor origin in which pathological changes in the tendinous origins of Extensor Carpi Radialis Brevis (ECRB) and Extensor Digitorum Communis (EDC) muscles are commonly implicated [43]. The tendons are relatively hypovascular proximal to the tendon insertion. The hypovascularity may predispose the tendon to hypoxic tendon degeneration and has been implicated in the etiology of tendinopathies. Most typically, the primary pathology in tendinosis of extensor carpi radialis brevis (ECRB) tendon 1-2 cm distant to its attachment on the lateral epicondyle [Altan, 2008., Jafarian,2009] [11] Being an overuse injury it is usually work related or sport related pain disorder with macroscopic or microscopic tears in extensor carpi radialis brevis, caused by excessive quick, monotonous, repetitive eccentric contractions and gripping activities of the wrist. LET is common between 30-60 years of age, the disorder appears to be more severe and of longer duration in females and the most commonly affected arm is the dominant arm [8]. The prevalence of LET in the general population is approximately 1.0-1.3% in men and 1.1-4.0% in women and was highest in subjects aged 45-54 years and 55-64 years and higher in women compared with men. There was no gender difference in the prevalence of definite LET [11]. The Hallmarks of diagnosis for LET was based on their clinical signs in the standardized health examination. The main complaints of LET subjects are decreased function and pain.

A plethora of physiotherapy techniques, electrotherapeutic and non - electrotherapeutic modalities, has been recommended for the management of LET. The aim of these treatments is the same, improving function and reducing pain, nut the theoretical mechanism of action of these treatments is different. The commonly used electrotherapeutic modalities for the treatment of LET are low level laser, transcutaneous electrical nerve stimulation, extracorporeal shockwave therapy, pulsed electromagnetic field therapy, therapeutic ultrasound and iontophoresis. The most common manipulative techniques are mulligan manipulation, mobilisation of the neck, manipulation of the wrist and radial neural mobilisation. Treatment focusing on trigger points reduces pain and improves function. Alfredson et al first proposed that eccentric training of the injured tendon, the most commonly used conservative technique in the management of tendinopathy [8]. The application of extremely low temperatures (cryotherapy) on conjunctive tissue and collagen makes it possible to improve quality of the cure of the damaged elements, stabilizing the articulations, muscular insertions, as well as tendons and ligaments [8]. Movement with mobilisation is a technique of manual therapy that includes a sustained lateral glide to the elbow joint with concurrent physiological movement [2]. The principles of the mulligan concept are based on the painless motion and therapy [6]. This technique often works to correct the faulty position of the elbow joint [2]. Author of this method Brain Mulligan built his techniques on the principles of manual therapy proposed by Kaltenborn and focused on restoration of the physiological movements of the joints. The therapist should first identify the signs

described by Maitland and including for example loss of joint movement, pain occurring during movement, pain related to the resisted wrist extension.

Therapy includes accessory glide performed parallel or perpendicular to the joint plane. The success of the therapy is confirmed by significant comparable sign indicating no pain[6]. Myofascial release (MFR) is the application of low load, long duration stretch to the myofascial complex, intended to restore optimal length, decrease pain, and improve function. MFR generally involves slow, sustained pressure (120-300s) applied to restricted fascial layers either directly (direct MFR technique) or indirectly (indirect MFR technique). Stanborough, myofascial practitioners believe that by restoring the length and health of restricted connective tissue, pressure can be relieved on pain sensitive structures such as nerves and blood vessels [13]. Studies also provides the evidence that MFR is most effective in controlling pain, studies done by Ajimsha et al., 2012 and Khuman et al., 2013 has shown similar results that, MFR plays an important role in reducing pain and improving functional performance in lateral epicondylitis patient, MFR plays a major role in relaxing the deeper tissue and provides lasting, effective relief of pain, when pain reduces there will be reduction of the muscle tightness and the muscle were relaxed and produced good amount of contraction [15].

MATERIALS AND METHODS

This study is based on Experimental study. The study was conducted in department of physiotherapy, Mohamed Sathak AJ College of Physiotherapy, Nungambakkam, Chennai.Data were collected from outpatient department of Mohammed Sathak A. J. college of Physiotherapy, Nungambakkam, Chennai. 40 Subjects who were clinically diagnosed with lateral elbow tendinopathy were included in the study. Subjects were selected based upon the fulfilment of inclusion criteria. The purpose of the study was explained to all subjects and consent from each subjects were obtained. Subjects were evaluated using numerical pain rating scale, range of motion, grip strength and PRTEE. Subjects were informed about the procedure, merits and demerits of the treatment. Participants were randomly assigned into two groups i.e, Group A(n= 20, Male – 8, Female – 12) (mulligan with movement with eccentric exercise and cryotherapy) and Group B (n= 20, Male – 11, Female – 9)(myofascial release technique with eccentric exercise and cryotherapy). All the Subjects were assessed before the commencement of treatment and also reassessed after 4 weeks of treatment.Total duration of 4 weeks was adopted in the study. Inclusion Criteria of this study includes Typical history of pain over elbow (lateral side).,Age ranging between 20-60 years., Both male and female are included in the study.,NPRS score of 4 and above., No history of trauma,Normal x-ray of the arm. Exclusion Criteria of this study is History of fracture, History of dislocation, History of surgery, Bilateral elbow pain,Active medications, Disease pertaining to elbow, Neuromeningeal involvement.Material used - Treatment couch, Foot stool,Chair, Pillow, Bedsheet, Mulligan's belt, Goniometer, Sphygmomanometer, Ice packs, Towel, Pen, White paper with clipboard, Scoring sheet to record NPRS, ROM, GRIP STRENGTH, PRTEE scores.

PROCEDURE
Group A: Mulligan with Movement Mobilisation
The subjects were positioned in supine lying, with elbow in full extension and forearm in pronation. The mulligan mobilization belt was placed around the proximal forearm close to the therapist while the distal humerus was stabilized with one hand. The subjects were then asked to make a fist and a sustained lateral glide was applied to the subject's forearm through the belt and sustained for about 10 – 15 seconds, as the therapist maintained the lateral glide. The mobilization technique were done for a total of 36 times. A short rest period (a few seconds) were given after every 12 repetitions and treatment was given for 3 sessions per week, for 4 weeks.

Group B: My of Asocial Release Technique
The myofascial release protocol was carried out in three forms.

Subject's position: Supine. The shoulder were internally rotated, the elbow pronated andflexed to around 15 degrees. The palm were resting flat on the table. The therapist in Standing on the side of the table at the level of patient's shoulder and facing the eipsilateral hand.

Technique 1: Treating from the common extensor tendon to the extensor retinaculum of the wrist, the therapist began on the humerus, just proximal to the lateral epicondyle. The therapist used the fingertips to engage the periosteum and carried this contact inferior to the common extensor tendon and then down to the extensor retinaculum of the wrist (5min x 2 repetitions). Subjects were trained to slowly flex and extend the elbow within an easy range of 5 to 10 degrees during the procedure

Technique 2: Treating through the periosteum of the ulna, the therapist used the knuckles of the hand to work over the periosteum of the ulna. Subjects were trained to do alternating ulnar and radial deviations of the wrist, while periosteum of ulna was engaged (5min x 2 repetitions).

Technique 3: Spreading the radius from the ulna, the therapist contacted the head of the ulna with the finger pads of one hand and the dorsal tubercle of radius with the pads of the other. The therapist engaged through the periosteum and put the line of tension in a lateral and distal direction. This was carried for just a few centimeters with a firm intent to spread the bones apart (5min x 2 repetitions).

Treatment duration: The intervention were provided 3 times weekly for 4 weeks, with a minimum of 1 day gap between the 2 sessions. The duration of each treatment session was 30minutes.

Common Interventions for Group A and Group B:
Eccentric Exercise [23]
The eccentric exercise program consisted of slow progressive exercise of the wrist extensors. Eccentric exercises of the wrist extensors were performed with elbow on the bed in full extension, the forearm in pronation, wrist in extended position (as high as possible), and the hand hanging over the edge of the bed. From this position, the subject flexes the wrist slowly while counting to 30, then returned to the starting position with the help of other hand. Subjects were told to continue this exercise even if they experienced mild pain. However, they were told to stop the exercise if the pain became disabling. When the subjects were able to perform the eccentric exercises without experiencing any minor pain or discomfort, the load was increased using free weights.

Treatment duration
The exercise programme was given with three sets of ten repetitions with one minute rest interval between each set. It was performed for 5 times a week for 4 weeks and was individualized on the basis of subject's description of pain experienced during the procedure. Ice was applied for 10 minutes in the form of ice bags/cold packs to the painful area. Cryotherapy was given after the exercise programme for 4 weeks.

RESULTS AND DISCUSSION

The analysis been done before and after treatment for both the groups and the results were tabulated and shown in table 1 to table 5. In the present study, a screening of 60 volunteers who were clinically diagnosed with lateral elbow tendinopathy present at the Physiotherapy department of Mohamed Sathak AJ College of Physiotherapy; in that 50 subjects fulfilled the inclusion criteria of which 10 subjects not willing to participate in this study. The remaining 40 subjects were included and they are already clinically diagnosed as LET. Those 40 Subjects were randomly allotted into 2 groups, 20 each (1:1 ratio). Group A received Mulligan with Movement with Eccentric Exercise and Cryotherapy; Group B received Myofascial Release Technique with Eccentric Exercise and Cryotherapy for a duration of 4 weeks; later all four standard outcome measures were measured after the study duration as pre test and post test values of NPRS, ROM, Grip Strength and PRTEE. This study shows that the pre test and post test of

Group A is effective based on the Mulligan with Movement with Eccentric Exercise with Cryotherapy on subjects Lateral Elbow Tendinopathy in terms of all standard measures. Similarly, the Group B is effective based on Myofascial release technique with eccentric exercise with cryotherapy on subjects with Lateral Elbow Tendinopathy in terms of all standard measures. The results of the study when comparing the pre – test and post – test, the post – test of Group B is proved to be effective when compared to Group A in subjects with Lateral elbow tendinopathy. On the whole, the mean difference of Group B "Myofascial release technique with eccentric exercise with cryotherapy" is slightly more effective than Group A "Mulligan with Movement with Eccentric Exercise with Cryotherapy" in terms NPRS Score, Flexion ROM Score, Extension ROM Score, Ulnar Deviation ROM Score, Radial Deviation ROM Score, Grip Strength Score and PRTEE Score. Lederman (1997) suggested that immediate pain relief can occur during various manual therapy techniques by sensory gating. Also pain is maximally gated by dynamic rather than static events applied close to the area of pain without inflicting further pain. Mulligan's concept uses mobilisation with movement close to the area of pain. According to Mulligan's hypothesis, tennis elbow pain will usually disappear when treated with appropriate elbow joint mobilisation**.**

In this study from table 1 & 2, there is significant mean decrease in NPRS scores due to Group A and the evidence is sufficient to conclude that the null hypothesis is rejected at 5% level (t(19)= 8.498, p = 0.000 < 0.05). Similarly from table 1&3, there is significant mean decrease in NPRS scores due to Group B and the evidence is sufficient to conclude that the null hypothesis is rejected at 5% level (t(19)= 9.695, p = 0.000 < 0.05). In this study when comparing the groups A and B from table 1&3, there is No significant difference between Group A and Group B in terms of average reduction in NPRS Score and the evidence is sufficient to conclude that the null hypothesis is accepted at 5% level (t(38) = -.975, p = 0.336> 0.05). Going by the mean values, we conclude that the average reduction in this NPRS Score due to "Myofascial release technique with eccentric exercise with cryotherapy (Group-B) is effective, thus the previous studies also supports the result of this study.This results was supported by Ratan khuman et al., (2013), stated that with any massage therapy techniques, the analgesic effect of MFR can also be attributable to the stimulation of afferent pathways and the excitation of Aδ fibres, which can cause segmental pain modulation as well as modulation through the activation of descending pain inhibiting systems.[14] Doctor S. Janet Travell and David Simons, in volume one of Myofascial Pain and Dysfunction: The Trigger Point Manual, demonstrated that myofascial trigger points in triceps and extensor muscles of the forearm can be the sole cause of the pain commonly diagnosed as lateral epicondylitis or tennis elbow. Thus previous studies results supports this study.According to Hampson K et al., (2008), mechanical conditioning can be used as a treatment for enhancing tendonhealing. Mechano-transduction is the process of a cell converting mechanical stimuli into biochemical signals Cells able to sense the mechanical signals are described as being mechano-sensitive. Tendon responds to mechanical forces by adapting its metabolism and structural and mechanical properties. Tendons adapt to alterations in the mechanical load being applied by changing their structure and composition.

The tenocytes in the tendon are responsible for its adaptive response, and respond to mechanical forces by altering their gene expression patterns, protein synthesis and cell phenotype, which can be used to aid the healing process.[11]Calfee (2008), describes the theory behind eccentric strengthening is to load the musculo-tendinous unit inducing hypertrophy and increasing tensile strength. This in turn reduces the strain on the tendon during activities. Eccentric contraction can create a greater stimulus for the cells of the tendon, producing collagen and resulting in the tendon being able to withstand greater forces.[11] Knight proposed that secondary hypoxic injury is a significant problem after injury. Cryotherapy reduces tissue temperature, slowing the rate of chemical reactions and, therefore, the demand for adenosine triphosphate (ATP). Decreased cellular ATP demand decreases the demand for oxygen, which leads to longer tissue survival during hypoxia. By decreasing the amount of damaged and necrotic tissue, the healing process can be shortened.[21] Pufe (2003), shows another possible mechanism for pain reduction by eccentric exercise is neo-vascularization. Tendinosis pain is also associated with neo-vascularization but the pain may stem from the mechanical stimulation of pressure-sensitive autonomic nerves in the muscular walls of the arteries.[11] According to Ohberg L et al., eccentric exercise may halt the growth of blood vessels in tendinosis and subsequently relieve some of the associated pain.[11] Calfee (2008), Decreasing neo-vascularization by eccentric exercise has been recently documented as another benefit of eccentric strengthening. It is believed that neo-vascularization is a causing

factor of pain in LE and other tendionpathies.[11] Craig R. Denegar et al., in their study showed that Slowing of nerve conduction velocity is the likely mechanism for the analgesic response to cold. Ice reduces nerve conduction velocity and slows the stretch reflex.[21] The mechanisms behind the reduction of pain was Lewis Hunting reaction, decreased metabolic activity at cellular level and decreased necrotic enzymatic activity thereby improving healing and recover function.[22]Lederman (1997) suggested that when correctional mobilisation is sustained, pain-free function is restored and several repetitions bring about lasting improvements. They also reported that mobilisation with movement is nearly always at right angles to the plane of movement and will work in only one direction. When correct MWM is repeated several times, the joint memory to stay on track seems to return (Mulligan, 1995).[3]In this study from table 1 & 2, there is significant mean increase in Flexion Scores due to Group A and the evidence is sufficient to conclude that the null hypothesis is rejected at 5% level (t(19)= -8.538 , p = 0.000 < 0.05). Similarly there is significant mean increase in Extension ROM Score due to Group A and the evidence is sufficient to conclude that the null hypothesis is rejected at 5% level (t(19)= -8.331, p = 0.000 < 0.05). From table 1&2, there is significant mean increase in Radial deviation ROM Score due to Group A "Mulligan with Movement with Eccentric Exercise with Cryotherapy" and the evidence is sufficient to conclude that the null hypothesis is rejected at 5% level (t(19)= -9.383, p = 0.000 < 0.05).

Similarly there is a significant mean increase in Ulnar deviation ROM Scoreand the evidence is sufficient to conclude that the null hypothesis is rejected at 5% level (t(19)= -6.899, p = 0.000 < 0.05). Koteeswaran et al., (2019), Myofascial trigger point release therapy is used to treat all fascial problem, studies have reported that the plastic, viscoelastic, and piezo electric properties of the connective tissues are regained through the application of MFR in lateral epicondylitis. MFR helps to reduce pain, by the application of treatment there will be sustained elongation of the fascia and the fascia back to its normal length.[15] as this studyresults results shows there is significant mean increase in Flexion ROM Scores due to Group B "Myofascial release technique with eccentric exercise with cryotherapy" and the evidence is sufficient to conclude that the null hypothesis is rejected at 5% level (t(19)= -8.552, p = 0.000 < 0.05). Similarly there is a significant mean increase in Extension ROM Scoreand the evidence is sufficient to conclude that the null hypothesis is rejected at 5% level (t(19)= -10.297, p = 0.000 < 0.05). In this study there is significant mean increase in Radial deviation ROM Score due to Group B and also there is a significant mean increase in Ulnar deviation ROM Score due to Group B and the evidence is sufficient to conclude that the null hypothesis is rejected at 5% level (t(19)= -7.906, p = 0.000 < 0.05).

When comparing groups A and B, in this study there is No significant difference between Group A and Group B in terms of average decrement in Flexion ROM Scores and the evidence is sufficient to conclude that the null hypothesis is accepted at 5% level (t(38) = -.710, p = 0.482 > 0.05). Going by the mean values, we conclude that the average increase in Flexion ROM Scores due to "Myofascial Release Technique with Eccentric Exercise with Cryotherapy (Group-B)" is effective. Similarly there is No significant difference between Group A and Group B in terms of average increment in Extension ROM scores and the evidence is sufficient to conclude that the null hypothesis is accepted at 5% level (t(38) = -.030, p = 0.976 > 0.05). Going by the mean values, we conclude that the average increase in Extension ROM score due to "Myofascial Release Technique with Eccentric Exercise with Cryotherapy (Group-B)" is effective. In this Study the resultsfrom tale 4&5 shows that there is No significant difference between Group A and Group B in terms of average increment in Radial Deviation ROM scores and the evidence is sufficient to conclude that the null hypothesis is accepted at 5% level (t(38) = -.691, p = 0.494 >0.05). Going by the mean values, we conclude that the average increase in Radial Deviation ROM score due to "Myofascial Release Technique with Eccentric Exercise with Cryotherapy (Group-B)" is effective.Similarly there is No significant difference between Group A and Group B in terms of average increment in Ulnar Deviation ROM scores and the evidence is sufficient to conclude that the null hypothesis is accepted at 5% level (t(38) = -1.049, p = 0.310 > 0.05). Going by the mean values, we conclude that the average increase Ulnar Deviation ROM score due to "My of ascial Release Technique with Eccentric Exercise with Cryotherapy (Group-B)" is effective. Our study results are supported by Alfredson (1999), states the decrease in pain may be a result from a lengthening of the musculo-tendinous junction creating less strain and allowing a greater range of motion. The biochemical model has become appealing, as many chemical irritants and neurotransmitters may generate pain in tendinopathy [11]. The greatest effect of reduced nerve conduction velocity through cryotherapy is shown in superficial nerves, and the effect of cold on nerve conduction velocity may last up to 30

minutes after application. When pain is effectively managed, the patient may be able to begin and progress rehabilitation sooner to address range-of-motion and strength deficits as well as progress to full weight bearing and functional activities more rapidly. Retarding secondary injury is an important theoretic benefit of cryotherapy. Secondary tissue death has been attributed to secondary enzymatic injury and secondary hypoxic injury [21]. A study by Yang in 2000, showed that mulligan mobilisation with movement technique was proposed to restore normal tracking of the radius over the capitulum so that strengthening of forearm muscles can be done without painful symptoms which leads to pain-free grip strength.[2]In this study From table 1,2&3, the results shows that there is significant mean increase in Grip Strength Score due to Group A "Mulligan with Movement with Eccentric Exercise with Cryotherapy" and the evidence is sufficient to conclude that the null hypothesis is accepted at 5% level (t(19)= -7.930, p = 0.000 < 0.05). Neeti Mishra et al., (2018), through their study found that Cyriax technique and Myofascial release technique both were effective in reducing pain and improving grip strength in patients with lateral epicondylitis. But MFR was effective that Cyriax in reducing pain and improving grip strength in patients with lateral epicondylitis [56]. From table 1,2&3 shows that there is significant mean increase in Grip Strength Score due to Group B "Myofascial release technique with eccentric exercise with cryotherapy" and the evidence is sufficient to conclude that the null hypothesis is rejected at 5% level (t(19)= -11.826, p = 0.000 < 0.05).

Khan (2000), claimed that eccentric training results in tendon strengthening by stimulating mechanoreceptors in tenocytes to produce collagen, which is probably the key cellular mechanism that determines recovery from tendon injuries.In addition, eccentric training may induce a response that normalizes the high concentrations of glycosaminogly can. It may also improve collagen alignment of the tendon and stimulate collagen cross-linkage formation, both of which improve tensile strength [11]. In this study From table 4&5,when comparing the groups A and B, there is No significant difference between Group A and Group B in terms of average increment in Grip Strength Score and the evidence is sufficient to conclude that the null hypothesis is accepted at 5% level (t(38) = -1.893, p = 0.066 > 0.05). Going by the mean values, we conclude that the average increase in Grip Strength score due to "Myofascial Release Technique with Eccentric Exercise with Cryotherapy (Group-B)" is effective and this was supported by previous studies by Krzysztof Zimmer (2003), they stated that the application of extremely low temperatures on conjunctive tissue and collagen makes it possible to improve quality of the cure of the damaged elements, stabilizing the articulations, muscular insertions, as well as tendons and ligaments [19]. Results of the study by Hazifur rahman et al., (2016), highlighted the effect of Mulligan techniques in increasing functional activities, as their experimental group showed more improvement of PRTEE (patient rated tennis elbow evaluation) than the control group [57]. In this study from table 1,2&3, shows there is significant mean decrease in PRTEE Score due to Group A "Mulligan with Movement with Eccentric Exercise with Cryotherapy" and the evidence is sufficient to conclude that the null hypothesis is accepted at 5% level (t(19)= 12.296, p = 0.000 < 0.05).

Our results are similar with that of Geetu and Deepak (2008) who found that MWM led to statistically significant improvement in functional performance [57]. Studies done by Ajimsha et al.,2012 and khuman et al., 2013 has shown similar results to our study, that MFR plays important role in reducing pain and improving functional performance in lateral epicondylitis patient, MFR plays major role in relaxing the deeper tissue and provides lasting, effective relief of pain. When pain reduces there will be reduction of the muscle tightness and the muscles were relaxed and produces good amount of contraction [15]. In this study from table 1,2 & 3 shows that there is significant mean decrease in PRTEE Score due to Group B "Myofascial release technique with eccentric exercise with cryotherapy" and the evidence is sufficient to conclude that the null hypothesis is rejected at 5% level (t(19)= 18.380, p = 0.000 < 0.05). on subjects with Lateral Elbow Tendinopathy. When comparing the groups A and B, from table 4&5 shows that there is No significant difference between Group A and Group B in terms of average decrease in PRTEE Score and the evidence is sufficient to conclude that the null hypothesis is accepted at 5% level (t(38) = -1.000, p = 0.324 > 0.05). Going by the mean values, we conclude that the average decrease in PRTEE score due to "Myofascial Release Technique with Eccentric Exercise with Cryotherapy (Group-B)" .Tipton et al., (1987) through their study, suggests that prescribed exercises which increase the force being transmitted to ligaments, tendon and bones will maintain and generally increase the strength and function a capacity of these structures [3]. Nigg (1999), Exercise can also increase the number and size of collagen fibrils and increase the cross-sectional area of tendons when compared with

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tendons of sedentary controls. In young mice, treadmill running or voluntary exercise appeared to slow age-related loss of glucosaminoglycans [3]. Stanish (2000), states that traditional treatment techniques were not directly addressing the issue of compromised tensile strength. Progressively overloading the tendon overtime through eccentric exercises would then lead to an increase in tensile strength [11]. Heenaben R. Rathwa et al., (2020), described that there was statistically significant improvement in PRTEE score in the group treated with cryotherapy. There was reduction of pain, improvement in pain pressure threshold and improved function in subjects treated with cryotherapy [22]. Thus this study results showed the mean difference of Group B "Myofascial release technique with eccentric exercise with cryotherapy" is slightly more effective in terms NPRS Score, Flexion ROM Score, Extension ROM Score, Ulnar Deviation ROM Score, Radial Deviation ROM Score, Grip Strength Score and PRTEE Score.

Testing the Mean Changes in Standard Measures in both Group A and Group B Groups
Testing the Mean Changes in Standard Measures due to Group A (Mulligan with Movement with Eccentric Exercise with Cryotherapy)

Hypotheses
Null hypothesis, H_0: There is no significant mean change in a standard measure due to Group A "Mulligan with

Movement with Eccentric Exercise with Cryotherapy" (i.e., μ_d = 0)
Alternative hypothesis, H_1: There is significant mean change in a standard measure due to Group A "Mulligan with

Movement with Eccentric Exercise with Cryotherapy" (i.e., $\mu_d \neq 0$)
Let the level of significance be $\alpha = 0.05$

Test to be applied: Paired Samples t-test

Test Statistic: $t = \dfrac{\overline{d} - \mu_d}{S_d}$,

where $\overline{d}$ = Mean of the differences of sample; d = $X_2 - X_1$ = Post Test Score – Pre Test Score; S_d = Standard error of the

difference; and μ_d = Population Mean difference to be tested

Testing the Mean Changes in Standard Measures due to Group B (Myofascial Release Technique with Eccentric Exercise with Cryotherapy)

Hypotheses
Null hypothesis, H_0: There is no significant mean change in a standard measure due to Group B "Myofascial Release

Technique with Eccentric Exercise with Cryotherapy" (i.e., μ_d = 0)
Alternative hypothesis, H_1: There is significant mean change in a standard measure due to Group B "Myofascial

Release Technique with Eccentric Exercise with Cryotherapy" (i.e., $\mu_d \neq 0$)
Let the level of significance be $\alpha = 0.05$

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Test to be applied: Paired Samples t-test

Test Statistic: $t = \dfrac{\bar{d} - \mu_d}{S_d}$,

where $\bar{d}$ = Mean of the differences of sample; d = X$_2$ – X$_1$ = Post Test Score – Pre Test Score; S$_d$ = Standard error of the difference; and μ_d = Population Mean difference to be tested

Comparison of Treatments in terms of changes in Standard Measures
Hypotheses:
H$_0$: There is no significant difference between Group A and Group B in terms of average changes in standard measures
H$_1$: There is significant difference between Group A and Group B in terms of average changes in standard measures
Let the level of significance be α = 0.05

Test to be applied: Independent Samples t-test

$$\sqrt{\frac{(n_1-1)s_1^2 + (n_2-1)s_2^2}{n_1+n_2-2}}$$

Test Statistic: $t = \dfrac{\bar{X_1} - \bar{X_2}}{S\sqrt{\frac{1}{n_1}+\frac{1}{n_2}}}$, where S = Pooled S.D =

$$\sqrt{\frac{(n_1-1)s_1^2 + (n_2-1)s_2^2}{n_1+n_2-2}}$$

CONCLUSIONS

Going by the results of the analysis, this study shows that the pre and post test of Group A is effective based on the Mulligan with Movement with Eccentric Exercise with Cryotherapy on subjects Lateral Elbow Tendinopathy in terms of all standard measures. Similarly, the Group B is effective based on Myofascial release technique with eccentric exercise with cryotherapy on subjects with Lateral Elbow Tendinopathy in terms of all standard measures. In addition, the difference between Group A and Group B was found to be statistically Non significant in terms of all standard measures for subjects with Lateral Elbow Tendinopathy. However, the result showed that the mean difference of Group B "Myofascial release technique with eccentric exercise with cryotherapy" is slightly more effective in terms NPRS Score, Flexion ROM Score, Extension ROM Score, Ulnar Deviation ROM Score, Radial Deviation ROM Score, Grip Strength Score and PRTEE Score.

RECOMMENDATIONS

Some of the strategies still to improve as evident from the study are stated below: Sample size can be increased and the Study duration can be increased. The long term effects of interventions can be determined and also the study can be done separately for both acute LET and chronic LET subjects with Population specific study can be done.

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Table-1: Paired Samples Statistics

Paired Samples Statistics of Group A & Group B		N	Mulligan with Movement with Eccentric Exercise with Cryotherapy - Group A			Myofascial Release Technique with Eccentric Exercise with Cryotherapy – Group B		
			Mean	Std. Deviation	Std. Error Mean	Mean	Std. Deviation	Std. Error Mean
Pair 1	NPRS_pre	20	7.1500	.74516	.16662	7.5000	.82717	.18496
	NPRS_post	20	4.1000	1.71372	.38320	3.9500	1.82021	.40701
Pair 2	FLX_pre	20	47.7000	5.12065	1.14501	47.5500	5.19590	1.16184
	FLEX_post	20	56.9000	3.97227	.88823	57.9000	2.95403	.66054
Pair 3	EXT_pre	20	45.9000	5.65592	1.26470	44.1000	5.00421	1.11898
	EXT_post	20	56.7500	4.30269	.96211	55.0000	3.62738	.81111
Pair 4	Rdev_pre	20	12.1000	2.38195	.53262	10.1500	2.83354	.63360
	Rdev_post	20	17.6500	3.06551	.68547	16.2500	1.94327	.43453
Pair 5	Udev_pre	20	20.1500	3.74552	.83752	17.9500	4.62800	1.03485
	Udev_post	20	26.9000	4.70050	1.05106	26.2000	3.13889	.70188
Pair 6	GRIP_pre	20	109.8450	6.96226	1.55681	104.5900	15.36424	3.43555
	GRIP_post	20	140.7850	16.91817	3.78302	145.3900	13.33002	2.98068
Pair 7	PRTEE_pre	20	72.1750	3.06626	.68564	72.4500	4.37968	.97933
	PRTEE_post	20	37.5250	12.57867	2.81268	34.3000	8.92424	1.99552

Table 2: Output of Paired Samples t-test

Paired Samples Test- Mulligan with Movement with Eccentric Exercise with Cryotherapy(Group A)									
GROUP A		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	NPRS_pre - NPRS_post	3.05000	1.60509	.35891	2.29879	3.80121	8.498	19	.000

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Pair 2	FLX_pre - FLEX_post	-9.20000	4.81882	1.07752	-11.45528	-6.94472	-8.538	19	.000
Pair 3	EXT_pre - EXT_post	-10.85000	5.82440	1.30238	-13.57591	-8.12409	-8.331	19	.000
Pair 4	Rdev_pre - Rdev_post	-5.55000	2.64525	.59150	-6.78802	-4.31198	-9.383	19	.000
Pair 5	Udev_pre - Udev_post	-6.75000	4.37547	.97838	-8.79778	-4.70222	-6.899	19	.000
Pair 6	GRIP_pre - GRIP_post	-30.94000	17.44870	3.90165	-39.10624	-22.77376	-7.930	19	.000
Pair 7	PRTEE_pre - PRTEE_post	34.65000	12.60232	2.81796	28.75193	40.54807	12.296	19	.000

Table-3 : Output of Paired Samples t-test

Paired Samples Test - Myofascial Release Technique with Eccentric Exercise with Cryotherapy– Group B									
GROUP B		**Paired Differences**					**t**	**df**	**Sig. (2-tailed)**
		Mean	**Std. Deviation**	**Std. Error Mean**	**95% Confidence Interval of the Difference**				
					Lower	**Upper**			
Pair 1	NPRS_pre- PRS_post	3.55000	1.63755	.36617	2.78360	4.31640	9.695	19	.000
Pair 2	FLX_pre- FLEX_post	-10.35000	5.41222	1.21021	-12.88300	-7.81700	-8.552	19	.000
Pair 3	EXT_pre - EXT_post	-10.90000	4.73398	1.05855	-13.11557	-8.68443	-10.297	19	.000
Pair 4	Rdev_pre - Rdev_post	-6.10000	2.38195	.53262	-7.21479	-4.98521	-11.453	19	.000
Pair 5	Udev_pre - Udev_post	-8.25000	4.66651	1.04346	-10.43399	-6.06601	-7.906	19	.000
Pair 6	GRIP_pre- GRIP_post	-40.80000	15.42933	3.45010	-48.02115	-33.57885	-11.826	19	.000
Pair 7	PRTEE_pre- PRTEE_post	38.15000	9.28227	2.07558	33.80576	42.49424	18.380	19	.000

Table-4 : Comparing the effect of Treatments Group A and B Post Test Mean Difference in terms of all measures

Group Statistics					
	GROUP	**N**	**Mean**	**Std. Deviation**	**Std. Error Mean**
NPRS_diff	A	20	3.0500	1.60509	.35891
	B	20	3.5500	1.63755	.36617
FLEX_diff	A	20	9.2000	4.81882	1.07752
	B	20	10.3500	5.41222	1.21021
EXT_diff	A	20	10.8500	5.82440	1.30238
	B	20	10.9000	4.73398	1.05855
Rdev_diff	A	20	5.5500	2.64525	.59150
	B	20	6.1000	2.38195	.53262
Udev_diff	A	20	6.7500	4.37547	.97838

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	B	20	8.2500	4.66651	1.04346
GRIP_diff	A	20	30.9400	17.44870	3.90165
	B	20	40.8000	15.42933	3.45010
PRTEE_diff	A	20	34.6500	12.60232	2.81796
	B	20	38.1500	9.28227	2.07558

Table-5 : Comparing the effect of Treatments Group A and B Independent Samples Test in terms of all measures

		Levene's Test for Equality of Variances		t-test for Equality of Means							
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
NPRS_diff	Equal variances assumed	.019	.890	-.975	38	.336	-.50000	.51273	-1.53797	.53797
	Equal variances not assumed			-.975	37.985	.336	-.50000	.51273	-1.53799	.53799
FLEX_diff	Equal variances assumed	.245	.623	-.710	38	.482	-1.15000	1.62039	-4.43030	2.13030
	Equal variances not assumed			-.710	37.499	.482	-1.15000	1.62039	-4.43174	2.13174
EXT_diff	Equal variances assumed	.911	.346	-.030	38	.976	-.05000	1.67831	-3.44755	3.34755
	Equal variances not assumed			-.030	36.476	.976	-.05000	1.67831	-3.45222	3.35222
Rdev_diff	Equal variances assumed	.000	.993	-.691	38	.494	-.55000	.79596	-2.16134	1.06134
	Equal variances not assumed			-.691	37.590	.494	-.55000	.79596	-2.16191	1.06191
Udev_diff	Equal variances assumed	.160	.692	-1.049	38	.301	-1.50000	1.43040	-4.39570	1.39570

		F	Sig.	t	df	Sig.	Mean	Std Error	Lower	Upper
	Equal variances not assumed			-1.049	37.843	.301	-1.50000	1.43040	-4.39609	1.39609
GRIP_diff	Equal variances assumed	2.441	.126	-1.893	38	.066	-9.86000	5.20827	-20.40359	.68359
	Equal variances not assumed			-1.893	37.439	.066	-9.86000	5.20827	-20.40878	.68878
PRTEE_diff	Equal variances assumed	4.833	.034	-1.000	38	.324	-3.50000	3.49985	-10.58508	3.58508
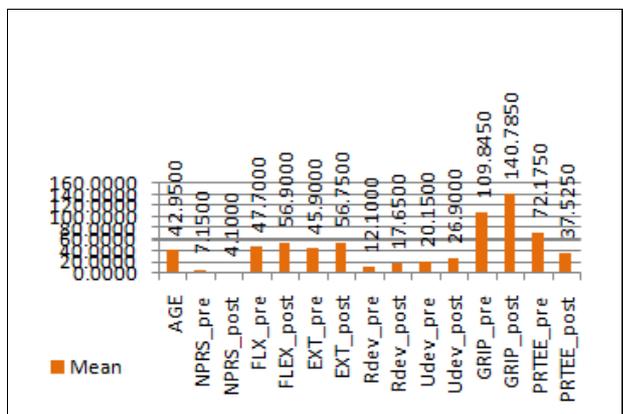
Fig: 1 Mean of Group A - Mulligan with movement with eccentric exercise with cryotherapy
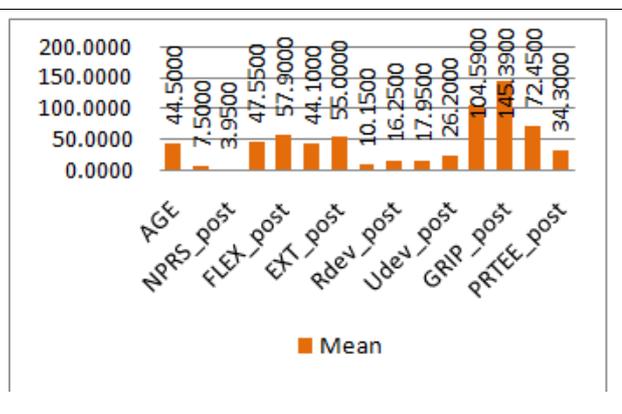
Fig 2: Mean of Group B - Myofascial release technique with eccentric exercise with cryotherapy
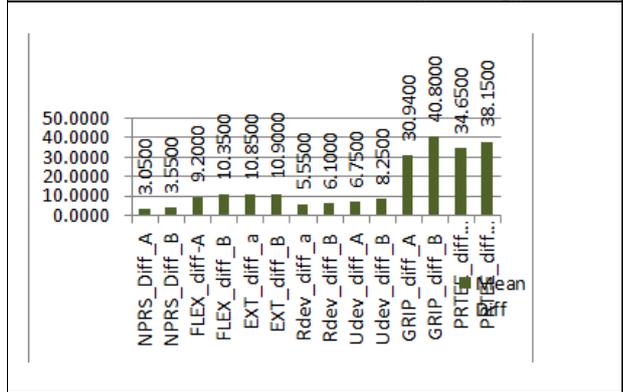
Fig 3: Mean Difference of Between Group A and Group B In Terms Of all measure

Fig.4: Subject receiving lateral glide in mulligan with movement mobilization

Fig.5: Subject receiving 1ˢᵗ technique of myofascial release technique

Fig.6: Subject receiving 2ⁿᵈ technique of myofascial release technique

Fig.7: Subject receiving 3rdᵈ technique of myofascial release technique

Fig. 8: Subject performing eccentric exercise

RESEARCH ARTICLE

Efficacy of Manjisthadi Yoga – An Analytical Study

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ABSTRACT

Human being has been very curious to know about their surroundings. This curiosity has led them to collect information through experiments and observations. Analytical chemistry is one of the most important disciplines of the science which deals with the qualitative and quantitative analysis of various substances. The word quality with reference to a dosage form is comprehensive and refers to characteristics like the potency, uniformity, purity, pharmacological action and stability etc. It is not only the moral duty of pharmaceutical manufacturers to produce effective, safe and nontoxic dosage forms but their legal responsibility as well. A manufacturer can do well to aim at precise control of the various quality attributes of his dosage forms so that he can market products with predictable performance and reproducible characteristics. Due to increased demand of Ayurvedic drug all over the world, it has been mandatory to develop standards for the raw drugs, in process materials, finished product to check the mal-practices in the herbal product. At the same time, consumer wants to know the quality of drug in terms of measurable parameters. so we described the Analytical study of Manjisthadi yoga.

Keywords: Manjisthadi yoga, Analytical study and Hepato protective.

INTRODUCTION

Acharya Vasiraj (divodasa dhanvantri king of Varanasi) has mentioned manjisthadi yoga in visharoga adhyaya. In all the forms of delivering medicine, in this study Manjisthadi Yoga Churna is one of the most beneficial forms. Seven Dravyas mentioned in Manjisthadi yogaviz., Manjistha, Haridra, Yashtimadhu, Ela, Jatamansi, harenuka and Draksa integrate vizhepato protective and Vishghan properties.[1]

Analytical Study
Although it's a delicate task to decide fix standard for Herbo- mineral medicine having a number of constituents, each component contains a large number of chemical ingredients in different attention. so we cannot imagine the commerce between these chemical element present in a emulsion medicine expression. But standardization of composites with single medicine is an easy bone. Indeed, parameters of standardization of single medicines like marker composites can be used to regularize the mixed expression to some extent.[2]

MATERIALS
1. Chemicals
2. Equipment

METHODS
1. Macroscopic and microscopic evaluation
2. Physiochemical evaluation
3. Qualitative analysis of extract to evaluate general phyto chemical profile.
4. Quantitative chemical analysis - TLC study.

Macroscopic and microscopic evaluation
Organo-leptic parameters
The specific characters which are mentioned in our classics for evaluating the qualities of preparation by color, touch, taste, odor, etc. were noted by Gyanendriya of above dosage forms. These characters are useful to both, the patient and physician for having primary idea about the quality of different formulations without using chemical tests.
Rupa (Color) - Brawn
Rasa (Taste) – bitter taste
Gandha (Odor) – characteristic odor
Sparsha (Consistency) – soft
Powder Microscopy Study after observation under microscope powder of Manjisthadi Yoga had found tracheid's, starch grain and xylem vessel.

Physicochemical evaluation
The ability of a chemical compound to elicit a pharmacological/ therapeutic effect is related to the influence of various physical and chemical (physicochemical) properties of the chemical substance on the bio molecule that it interacts with physical and chemical properties.

Determination of foreign matter
Medicinal plant content should be entirely free from visible signs of contaminations. Abnormal odor, discoloration, slime or signs of deterioration should be detected. It is seldom possible to obtain marketed plant materials that are entirely free from some form of innocuous foreign matter. Foreign matter is material consisting of any or all of the following:
1. Parts of the medicinal plant material or materials other than those named with the limits specified for the plant material concerned.
2. Mineral admixtures not adhering to the medicinal plant material, such as soil, stones sand and dust.

3. Any organism, part or product of an organism, other than that named in the specification and description of the plant material concerned.

Method

Genuine sample of plant material was weighed by the electronic monoplane balance and a thin layer of sample was spreader on a white color sheet. By bull lens, the layer was examined for foreign matter. Foreign matter was separated and collected in to another paper. Plant material was recollected and weight again. Percentage of foreign matter in relation to the total quantity of plant material has calculated.

Determination of moisture content

Take about 5 gm accurately weighed sample in powder form. Spread the material homogenously on dishes provided with the instrument. Place the dishes in the instrument and adjust the instrument accordingly at zero, set the temperature at 105 degrees Celsius. When the reading becomes constant in the circular scale for 15 minutes take the readings. The instrument directly determines the percentage loss.

Determination of pH

The pH value of an aqueous liquid may be defined as the common reciprocal of the hydrogen ion concentration expressed in gram per liter. It practical means the quantitative indication of the acidity or alkanity of a solution. The pH of a given solution is measured by using digital pH meter.

PROCEDURE

First the pH meter is standardized. To create solutions with a pH range between 4.7 and 9, one tablet of a different pH is dissolved in 100 ml of purified water (buffer solutions). The instrument is turned on till the need for a different pH solution on the board or unless it is left for a while. The electrode is dipped into the buffer solution that has been poured into the beaker. After carefully cleaning the pH meter with distilled water, repeat the process for the other buffer solutions. The sample is taken (2 gm + 20 ml distilled water) and dip electrode in it. pH value of the given sample is noted.

Determination of Total ash

Silica crucible has cleaned, dried well & labelled with glass pencils and then weighed to constant weight. 5 gm of powdered drug sample has put in the Silica crucible. The drug has spread evenly in to a thin layer. This crucible has placed in a muffle furnace and ignited at a temperature of 450°C for about 6 hrs. or more until the ash has totally free from Carbon. The crucible containing the ash has allowed to be cooled in desiccators and subsequently weighed to constant weight. The percentage of ash with reference to the air-dried drug has calculated as follows;

Calculation

1. Wt. of Empty Silica Crucible   = A_1 gm
2. Wt. of Sample (X)   = X gm
3. Wt. of the Crucible with Ash   = A_2 gm
4. Percentage of Total Ash   = $[(A_2 - A_1)/X] \times 100$

The process has repeated three times for each drug sample and the Average Total Ash value has calculated.

Determination of Water-Soluble Ash

Water soluble ash value was determined as per Pharmacopoeia of India 1996. Boil the total ash for 5 minutes with 25 ml of water; collect the insoluble matter in a Gooch's Crucible or on an ash less filter paper, Wash with hot water and ignite for 15 minutes at a temperature not exceeding 4500 C. Subtract the weight of the insoluble matter from the

weight of the ash; the difference in weight represents the water-soluble ash. Calculate the percentage of water-soluble ash with reference to the air-dried drug.

Calculation
1. Wt. of the empty Gooch's Crucible - G1 gm
2. Wt. of drug sample - X gm
3. Wt. of the Gooch's Crucible with water Soluble Ash - G2 gm
4. Wt. of total ash - A gm
5. Percentage of water -soluble ash – $\{A – [(G2 – G1)/X] \times 100\}$

Determination of Acid Insoluble Ash
Acid insoluble Ash value was determined as per Pharmacopoeia of India, 1996. Boil the total ash with 25 ml of 2M Hydrochloric acid for 5 minutes. Collect the insoluble matter in a Gooch crucible or on an ash less filter paper, wash with hot water, ignite, cool in adesiccator and weigh. Calculate the percentage of acid insoluble ash with reference to the air-dried drug.

Calculation
1. Wt. of drug sample - X gm
2. Wt. of empty Gooch's Crucible with filter paper - G1 gm
3. Wt. of the Gooch's Crucible with residual ash - G2 gm
4. Percentage of acid insoluble ash – $[(G2-G1)/X \times 100]$

In the plants, two types of phyto chemicals are present,
• Inorganic matters
• Organic matters.

All electrolytes fall under the category of inorganic matter because they are devoid of carbon. Organic Matters are byproducts of secondary metabolites in plants. These ingredients play a crucial role in medicine. Both qualitative and quantitative analyses of both organic and inorganic materials were conducted

Qualitative examination of Inorganic matters
It involves qualitative analyses of the electrolytes found in the sample's ash. Higher plants need sixteen or seventeen components for development and reproduction. Macronutrients are substances that must be consumed in relatively large amounts, whereas micronutrients are substances that must be consumed in relatively tiny amounts. These substances are all depleted through various metabolic processes. These components are incorporated into a variety of organic molecules that plants manufacture to form their chemical structures. their presence can be detected by simple chemical analysis.

Determination of Extractive values
Extraction of plant material is done as per API suggested method. Solvents which were taken for extraction are as follow:
1. Methanol
2. Distilled water
3. Petroleum ether
4. Chloroform
5. Benzene

Determination of Alcohol Soluble Extractive
5 g coarsely powdered airdried drug is macerated with 100 ml of Alcohol of the specified strength in a closed flask for twenty-four hours. Continuously shake for six hours using rotary shaker and allowed to stand for eighteen hours. The content is filtered using filter paper. The filtrate is transferred to a pre-weighed flat-bottomed dish and

evaporated to dryness on a water bath. Then the dish is kept in oven at 105º, to constant weight and weigh. The percentage of alcohol-soluble extractive is calculated with reference to the air-dried drug.

Determination of Water Soluble, Chloroform and benzene Extractive
Extractive value of samples is determined by following the above procedure.

Determination of Ether Soluble Extractive using Soxhlet apparatus
Coarsely powdered airdried drug material is accurately weighed and taken in a round bottom flask. The flask is filled with solvent and connected to an extractor and condenser. The flask is heated on a heating mantle until colorless solvent began to collect in the collecting tube. After the flask has cooled, the solvent is filtered through filter paper. The filtrate is then transferred to a flat-bottomed dish that has been previously weighed and dried on a water bath. The dish is then placed in the oven for six hours so that the contents can completely dry out. The dish is immediately weighed after cooling for 30 minutes in a desiccator. The remaining matter in the filter paper is completely collected after being dried in this manner.

Calculations
1. Weight of the drug material - X gm
2. Weight of the empty Petri dish - W_1 gm
3. Weight of the Petri dish with dried extract - W_2 gm

$$\frac{(W_2 - W_1)}{X} X 100$$

4. Percentage of extractive value -
The procedure has repeated three times and the mean value has calculated.

Phyto chemical Examination
Qualitative tests for various functional groups
Tests for Carbohydrates
1. Molisch test
2. Benedict test
3. Barfoed test
4. Seliwanoff's test
5. Fehling solution test

Molisch's Test
2 ml of test Solution was taken in a test tube and 2 ml of the Molisch's reagent was added and shaken carefully and then about 1ml. of conc. H_2SO_4 is poured from side of the test tube and allowed to stand for one 1 minute. A Purple color ring at the junction of the two layers if formed indicated the presence of Carbohydrate.

Benedict's test
It is used to reduce sugars and is mostly made of sodium hydroxide and copper sulphate. 1 ml of Benedict's solution was added to the 4 ml of drug's aqueous solution and heated almost to boiling. As the concentration of simple sugar in the test solution rises, cuprous oxide forms, giving the solution a green, yellow, orange, red or brown.

Barfoed's test
The test sample was dissolved in water and heated with a little of the Barfoed's reagent. Formation of red precipitate of cuprous oxide within two minutes indicates the presence of monosaccharides.

Seliwanoff's test

This test is used to identify keto-hexoses or to tell ketoses and aldoses apart. 5 ml of Seliwanoff's reagent (resorcinol in 6M HCl) was added to 1 ml of the drug's aqueous solution, heated, and then added. Due to the synthesis of hydroxyl methyl furfural, which condensed with resorcinol to produce cherry red color, cherry red color is produced when ketose (Fructose) is present.

Fehling solution test

It often works for lowering sugars and is made up of two solutions that are blended on the spot. While Fehling solution B contained sodium potassium tartrate, Fehling solution A contained copper sulphate at a concentration of 0.5 percent. Equal parts of Fehling A and B solutions (1 ml each) were combined, and 2 ml of the drug's aqueous solution was then added. The mixture was then heated on a water bath for 5 to 10 minutes. The presence of reducing sugar is indicated by the reddish brown colour of the precipitate that forms when cuprous oxide is formed.

Tests for Alkaloids

1. Dragendorff's Test
2. Mayer's Test
3. Wagner's Test
4. Hager's test

Dragendorff 's Test

Potassium bismuth iodide and the drug solution combine to produce an orange-red colour.

Mayer's Test

Creamy-white precipitant is produced by adding a few drops of Mayer's reagent (K2Hg I4) to the drug solution.

Wagner's Test

A reddish-brown precipitate is produced by mixing Drug Solution with a few drops of Wagner's Reagent (diluted Iodine Solution).

Hager's Test

For this test, a saturated aqueous solution of picric acid was used. An orange-yellow precipitate was produced after the test filtrate was treated with this reagent, indicating the presence of alkaloids.

Test for Amino acids
Ninhydrin test

Alpha-amino acids and proteins with free amino groups can be found using the Ninhydrin assay. Due to the development of a complex between two ninhydrin molecules and the nitrogen of free amino acids, protein solution heated with ninhydrin molecules turns a distinctive deep blue or light yellow color.

Tests for Proteins

1. Biuret test
2. Xantho-protic test
3. Millon's test

Biuret test

A few mg of the residue were dissolved in water, and 1 ml of a 4 percent sodium hydroxide solution and a drop of a 1 percent copper sulphate solution were then added. Proteins are present when violet or pink color development occurs.

Xantho-protic test

It is used to identify proteins that include aromatic ring-containing amino acids or amino acids with aromatic rings in them. Add 2 ml of 65% HNO3 to the 2 ml of amino acid/protein aqueous solution in the test tube. The presence of an aromatic ring containing an amino acid, such as tyrosine or tryptophane, is indicated by the formation of a yellow precipitate as a result of nitration of the aromatic ring.

Millon's test

Any substance with a phenolic hydroxyl group will result in a positive Millon's test. Mercuric and mercurous ions are dissolved in nitric and nitrous acids to form the Millon's reagent. Place a few drops of Millon's reagent in a test tube with 1 ml of protein solution. White precipitate is created, and after heating on a water bath for five minutes, it turns red.

Test for saponin
Foam test

To 1 gm of drug add 10-20 ml of water, shake for few minutes, formation of frothing which persists for 60-120 seconds indicates presence of saponins.

Test for glycosides
Killer Killani test

To the alcoholic extract of drug, equal volume of water and 0.5 ml of strong lead acetate solution was added,shake and filtered. Filtrate was extracted with equal volume of chloroform. Chloroform extract was evaporated to dryness and residue was dissolved in 3 ml of glacial acetic acid followed by addition of few drops of $FeCl_3$ solution. The resultant solution was transferred to a test tube containing 2 ml of conc. H_2SO_4. Reddish brown layer is formed, which turns bluish green after standing due to presence of digitoxin.

Borntrager's Test

1 ml of Benzene and 0.5 ml of dilute ammonia solution has added to the ethanolic extract and observed for the formation of reddish pink color.

Test for Phenolic Compound

The extract has taken in water and warmed; to this 2 ml of ferric chloride solution has added and observed for the formation of green and blue color.

Test for Flavonoids
Shinoda test

To the alcoholic extract of drug Magnesium turning and dil. HCl has added, formation of red color indicates the presence of flavonoids.

Test for Steroids
Salkowski reaction

Few mg of extract was taken in 2 ml of chloroform and 2 ml of concentrated sulphuricacid was added from the side of test tube. The test tube was shaken for few minutes. The development of red color indicates the presence of sterols.

Test for Tannin
$FeCl_3$

A 5 percent solution of ferric chloride in 90 % alcohol was prepared. Few drops of this solution were added to a little of the above filtrate. Appearance of dark green or deep blue color indicates the presence of tannins.

Lead acetate

A 10 percent w/v solution of basic lead acetate in distilled water was added to the test filtrate. Development of precipitate indicate the presence of tannins.

Potassium Dichromate

A solution of potassium dichromate was added to the filtrate. Appearance of dark color indicates the presence of tannins.

Bromine water

Bromine solution was added to the filtrate. Decolorization of bromine water indicates the presence of tannins.

THIN LAYER CHROMATOGRAPHY (T.L.C.)

Thin layer chromatography is a technique to separate the compounds from a mixture based on adsorption principle. It has the advantage of faster runs, better separations, and the choice between different adsorbents. It enables the qualitative, semi qualitative and qualitative evaluation of phytochemical constituents of herbal drugs. This allows the calculation of an R_f value and can be compared to standard compounds to aid in the identification of an unknown substance.

Calculation of Rf value

$$Rf = \frac{\text{Distance traveled bysolute from origin line}}{\text{Distance traveled bysolvent from origin line}}$$

Chromatography plates

T.L.C. plate coated with 0.25 mm layer of silica gel GF 254 with fluorescent indicator, (Mercks) were used. Each plate having dimension 10 cm long and 2 cm width.

Activation of pre-coated Silica gel G60F254

Allowed to dry in hot oven at 105^0 C for one and half hour.

Preparation of mobile solution

Toluene and Ethyl Acetate was mixed at the ratio of 9:1

Sample application

Sample was applied with the help of capillary 1(one) cm above the base of T.L.C. plate. Then it was dipped in mobile solution. T.L.C. plate was removed from the mobile solution immediately after the spot reached 1(one) cm below the top of the T.L.C. plate.

Visualization

1. Under U.V. Short wave
2. Under U.V. Long wave
3. Under Iodine Vapor
4. Under Valinin Sulphuric Acid.

RESULTS

Pharmacognosy and Quality Control Study
Powder Microscopy
Powder Microscopy Study after observation under microscope powder of *Manjisthadi Yoga* had found tracheid, starch grain and xylem vessel.

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DISCUSSION

The test formulation Manjisthadi Yoga, comprising seven important ingredients which are well known for their hepato protection activity has been found to have good hepato protective activity. In Analytical study showing these characteristics are helpful in determining the quality of formulation. The appearance of Manjisthadichurna was dark brown in color, soft in touch, with characteristic odor and bitter taste. Powder Microscopy Study after observation under microscope powder of Manjisthadi yoga had found tracheid, starch grain and xylem vessel. Physicochemical analysis- Loss on Drying of Manjisthadi Churna was found to be 7.43,Total Ashvalue is 7.32 %, Manjisthadi Churna contains 3.78 % of siliceous content, Water soluble extractive value was 21.34%, Alcohol soluble extractive value was 15.76 %. Phytochemical test- Molisch test is positive in aqueous and ethanol extract, Benedict test is positive in aqueous extract of samples which indicates the simple sugar may be present.

Fehling test was positive in aqueous extract of sample that indicates reducing sugar were present. Alkaloids were identified in aqueous extract due to positive of Dragondroff test and Hager's test and ethanol extract due to positive of Wagner's test. Amino acid are present in both extract due to show positive result in Ninhydrin test and protein are present in test sample due to positive in Biuret test in aqueous and Ethanol extract and Xanthoprotein test in aqueous extract. Foam test was positive in aqueous extract of sample that indicates saponin was present. Phenolic test was positive in aqueous extract of sample that indicates phenolic compounds was present. Salkowski reaction was negative in aqueous extract and alcoholic extract of sample that indicates steroids was not present. $FeCl_3$ test, lead acetate test was positive in test sample that's indicate that tannin is present in sample. Aflatoxin are toxins produced by mold that can damage the liver and may lead to liver cancer and produce toxicity in vital organs of human and animals. Aflatoxin B1, B2, G1, G2 was absent in test sample of Manjisthadi Yoga Churna.

CONCLUSION

Seven Dravyas mentioned in Manjisthadi yogaviz., Manjistha, Haridra, Yashtimadhu, Ela, Jatamansi, harenuka and Draksa possesses hepato protective and antioxidant activity. These seven dravyasare Vishaghna, Shothaghna, Raktashodhaka and Tridoshashamaka. Hence can be useful in the management of Hepato toxicity. Among these seven dravyas Haridra, Manjistha and Draksaare more effective.

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Table no.-1List of chemicals used during the dissertation work are listed below

Hydrochloric acid	Sodium hydroxide	Potassium ferrocyanide
Distilled water	Acetic acid	H_2S Gas
Sulphuric acid	Potassium chromate	Toluene
Potassium thiocynate	Potassium iodide	Hypophosporus
Magnesium reagent	Ammonia	Lead acetate
Molybdate reagent	Ammonium chloride	Potassium bismuth iodide
Perchloric acid	Sodium sulphide	Vanillin
Barium chloride	Sodium potassium tartarate	Ferric chloride
methanol	Ethanol	Chloroform
Molisch's reagent	Iodine solution	Pyridine
Seliwanoff's reagent	Copper sulphate	Magnesium turning
glycerine		

Table no.-2 List of equipment and apparatus used during the dissertation work.

Digital balance	Soxhlet extractor
Magnifying Bull Lens	Condenser
Hot air oven	Heating mantle
Silica crucible	Hot plate
Grinder	Water bath
Muffle furnace	Common glass wear
Dessicators	Rotary shaker
TLC chamber	

Table no.- 3 Powder Microscopy

Tracheid	Xylem vessel	Starch Grain
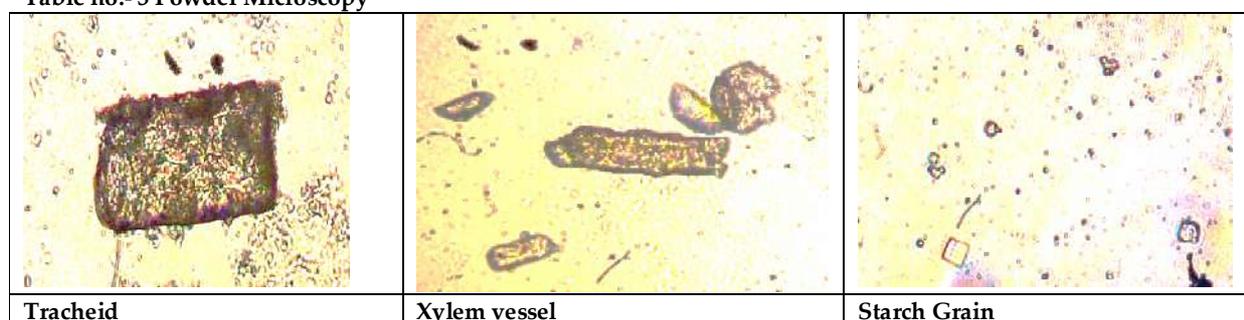
Table no.-4 Physiochemical Analysis

S. No.	Test	Value
1	Loss on Drying (%)	7.43
2	Foreign Matter (%)	0.00
3	Aqueous Extractive Value (%)	21.34
4	Alcoholic Extractive Value (%)	15.76
5	Total Ash (%)	7.32
6	Acid Insoluble Ash (%)	3.78
7	Water Soluble Ash (%)	4.96

Table no.-5 Phyto chemical Screening

Name of Test	Aqueous Extract	Alcoholic Extract
Carbohydrate		
Molish test	+ve	+ve
Benedict test	+ve	+ve
Fehling test	+ve	-ve
Alkaloids		
Dragendorff test	+ve	-ve
Wagner's test	-ve	+ve
Hager's test	+ve	-ve
Amino acids		
Ninhydrine	+ve	+ve
Protein		
Biuret test	+ve	+ve
Xenthoprotic test	+ve	-ve

Saponin		
Foam test	**+ve**	-ve
Glycosides		
Borntrager's test	**+ve**	-ve
Phenolic compound		
Phenolic test	**+ve**	-ve
Steroids		
Salkowaski	-ve	-ve
Tannins		
Fecl$_3$	**+ve**	-ve
Lead acetate	**+ve**	**+ve**
Pot. Dichromate	-ve	-ve

Table no.- 6 Aflatoxin

S. No	Aflatoxin	Value		Test method
		Value	Reference Value	
1	Aflatoxin B1	Not Detected	0.5 PPB	A.P.I, Part II, Vol-I, Appendix - 2.7
2	Aflatoxin B2	Not Detected	0.1 PPB	
3	Aflatoxin G1	Not Detected	0.5 PPB	
4	Aflatoxin G2	Not Detected	0.1 PPB	

Table no.- 7 Thin Layer Chromatography

R$_f$ Value: 0.09, 0.16, 0.56, 0.59, 0.73, 0.94

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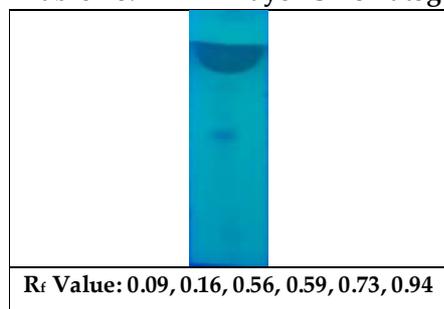
Verification of Hybrid Model for Big Data Privacy-Preserving in D2D Communication Implementation and Security

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ABSTRACT

The flow of datasets among physically adjacent gadgets is made easier by D2D (Device-to-Device) communications, which adds a novel feature to the cell phone landscape. D2D interaction makes use of neighboring communicating gadgets to accomplish an efficient usage of the assets accessible, minimize delay, enhance dataset speeds, as well as boost network performance. Every activity taken by the cell phone provider to gather shorter range telecommunications for the upkeep of proximity rooted applications as well as enhance network throughput propels the growth of D2D in the modern era. This study provides a thorough analysis of various improvements to D2D communication secrecy that have been suggested in recent years. In this article, the authors suggested a novel scheme for Implementation and Security Verification of Hybrid Model for Big Data Privacy-Preserving in D2D Communication. We also emphasize the unsolved issues as well as outline the difficulties related to the D2D networking issue. The outcome of the proposed scheme demonstrates that our approach offers higher secrecy in big data privacy preservation within D2D communication. The overall measured optimum weight of the proposed scheme in the first trial and from 1 to 7 rounds were measured 110, 112, 118, 126, 128, 130, and 126 respectively. In the future, there can be more investigations for improving the secrecy and privacy of extremely larger datasets within D2D communication.

Keywords: Big Data, D2D Communication, Privacy-Preserving, Security Verification.

INTRODUCTION

Nowadays new communication gadgets and cutting-edge technology are tremendously changing the lives of people all across the globe. These new kinds of the gadgets such as smart phones, computing devices, as well as tablets are helping people in diverse ways namely both types of communication i.e. calling and text messaging, image datasets exchange, and many more. This kind of huge amount of data is exchanged in day to day lives of the people with the help of the internet[1], [2]. These kinds of communication gadgets help people in exchanging information as well as multiple datasets files with each other, particularly within mobile computing as well as wireless communication. However, the accessible mobile environment mainly depends on the global network infrastructure[3]–[6]. Further, the smart phone consumer's connectivity is finite and mainly depends on the base station covering the region as well as doesn't allow for straight communication amongst the gadgets. Although the main source, as well as the final destination, are in adjacent vicinity to one another, the entire routing rush is mainly routed via a central network[7], [8]. Because of this inefficacy, the chances of the datasets exchanging between diverse cellular smart phone consumers are restricted, particularly allowing for transformation procedure of individual computing from portable computing machines to laptop devices as well as lastly the portable mobile gadgets. The secrecy of this massive amount of the big datasets during transmission from one end to another is becoming a huge threat and demands sophisticated and less computing complexities solutions in the modern era[9]–[11].

D2D telecommunications are referred to as a connectivity innovation that allows for straightforward interaction between gadgets even without straightforward participation of stationary networking environment, such as APs (Access-Point), as well as BS (Base-Stations), including the wireless-fidelity (Wi-Fi) straight [12] and Bluetooth, as well as could function within an exclusively self-governing manner. Within the identical mobile spectrum, D2D interactions may be deployed as a limited or regulated underlying networking of the long-term evaluation LTE Advance-networking [13], [14]. Cell phone carriers have created novel business strategies including novel application contexts centered upon D2D telecommunications to suit marketplace needs for contextual recognition as well as vicinity operations, as well as for ubiquitous sociable connecting including disaster solutions. D2D telecommunications are a potential innovation that has drawn a significant amount of awareness from the academic community, business, and especially more recent standardization bodies. D2D transmissions are seen as the foundation of LTE Advance-level networking within the academic community from the start. Numerous studies concentrate on investigating D2D implementation contexts, resource distribution telecommunication medium choice, interruption management, including power management [15]–[17].

Figure 1 illustrates the major identified big data secrecy-related threats in the D2D communication environment. D2D telecommunications have indeed been recognized as a cutting-edge innovation for the forthcoming wave of cellular technology including wireless telecommunication infrastructure. To fend against harmful assaults, D2D telecommunication datasets must be safeguarded. Encrypted D2D transmissions between handheld phones, meanwhile, remain a challenge. In this article, researchers present a method for regulating D2D telecommunication data accessibility by implementing an attribute-rooted encryption procedure for ensuring the confidentiality of the big datasets in the entire communication procedure. This novel approach could indeed be implemented utilizing either a GT (General-Trust) grade provided by central networking or a LT (Local-Trust) degree assessed through a gadget or even both in real-time.

LITERATURE REVIEW

In [17], U.N. Kar et al. conducted a review on D2D communication within a mobile cellular networking environment. D2D telecommunication, which offers much-reduced delay for consumer interaction, is anticipated to serve a large part in emerging cellular infrastructures. Either licensed or unlicensed bandwidth could be used by this novel concept. It represents a fresh improvement on the established wireless telecommunication concept. Nevertheless, despite its advantages, there are several economic but also technological problems that must be overcome before it is integrated into the wireless environment. The basic traits of D2D telecommunication are

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covered throughout this article, along with its use contexts, framework, and technological aspects, including current investigation fields. The usage of D2D within cellular networking has indeed been examined across several researches. For instance, to lower the same expenses of ground controlling headquarters resulting from the requirement of organizing cars throughout vast numbers as coding peddlers, the researchers of [18] suggested a machine-learning-rooted coding dissemination system. This method chooses cars with a greater covering ratio as well as dependability as coding distributors. Through suggesting a process orchestration as well as datasets aggregation architecture which may provide solutions for organizing the datasets including merging data packages. Liu et al. minimized the operation reply latency as well as duplication of datasets in [19].In [20], B. Yang et al. discussed an automated repairing scheme for D2D telecommunication routing in real-time. For improving the secrecy along with the communication quality effective maintenance of the cellular network is very essential. Owing to increased client activity, communication datasets easily cross the buffer's edge, decreasing the amount of protected dataset information. The issue of inadequate telecommunication secrecy is caused by the fact that previous restoration techniques primarily focus on the features of covering dataset information, neglecting the influence of networking infrastructure data transfer latency as well as packet failure throughout estimation. However, this approach is inefficient in the case of larger datasets translation on the limited bandwidth channels owing to the constant increment in the number of consumers all around the world.

In [21],A. Ozhelvaci et al. discussed another article on handover secrecy as well as D2D telecommunication within the 5G (5th Generation) Het Nets. Technical specifications for these currently being developed coming-generation cellular communication technologies are set by the 3GPP (Third-Generations and Partnership-Project (3GPP). This is indeed known as 5G cordless cellular networking, which has emerged as the model for bringing not just answers to the growing need for vast amounts of dataset transmission but also enormously linked objects, for example, the IoT (Internet-of-things) and many other additional activities. Additionally, 5G is anticipated to provide the quickest, best dependable networking connection to accommodate vast dataset traffic as well as terminals that are heavily linked with minimal delay as well as excellent capacity. However, this approach contains numerous limitations namely the more computational complexity. In [22], X. Chen et al. discussed the investigation growth scheme on the big datasets secrecy technique. A big dataset has a tremendous impact on folks' life as a fresh but dynamic area of financial growth, a creative accelerator of societal growth, as well as a smart instrument for defining country competence. Increased adoption of big dataset uses is, nevertheless, being hampered more and more by big data protection due to increased societal knowledge of the worth of dataset and the rapid growth of big dataset platforms. A single big data privacy paradigm has not yet been developed, but as big dataset technologies as well as architecture continue to advance, academics continue to have divergent views on that fundamental concept as well as essential elements of big dataset security.

METHODOLOGY

Design

This article presents the major challenges related to the big data sets' secrecy as well as confidentiality within D2D telecommunication. For resolving the big datasets secrecy threats, the researchers developed a most suitable scheme for secrecy verification of the hybrid model for the big datasets privacy-preserving within the D2D telecommunication in real-time. Our proposed scheme ensures the confidentiality as well as secrecy level of the uses by generation and verification of the unique IDs in real-time and matches all the data within the database in an accurate and faster manner for avoiding any latency in the dataset communication procedure. Figure 2 illustrates the flow diagram of our proposed scheme for security verification of a hybrid model for big data privacy-preserving in D2D communication. The working procedure of our proposed scheme is described as follows. First, the initialization procedure begins for the registration of diverse users namely the US1, US2 up to USn within the database for main network accessibility. In the next step, the unique IDs of multiple users are to generated such as UID1, UID2 up to UID n in real-time. If verification of the user is found inaccurate in registration due to mismatch or wrong data input it goes to the previous step.

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While the unique IDs verification is done accurately it goes to the subsequent steps in real-time. After accurate user verification, the collection of the D2D communication records is done, and based upon that the datasets are to be encrypted for maintenance of secrecy at the same time by using the most recognized enhanced AES algorithm. In the next step, the weights are to be evaluated with accuracy based on the execution of the developed enhanced AES algorithm. Later the privacy level categorization, as well as datasets translation to the channel, is done finally after proper verification and encryption of the datasets in real-time D2D communication.

Instrument

The verification and secrecy assessment of the suggested scheme is done by utilizing Hadoop, which is indeed a Map Reduce-rooted software paradigm. The entire testing procedure of the proposed scheme is done by utilizing the described system structure: AMD Ryzen 7, 64-bit operating system, SSD (Solid State Drive) 512 GB and integrated with the 16 GB RAM. Map Reduce is indeed a pragmatic and faster software paradigm as well as a programming prototypical utilized for processing gigantic datasets. This Map Reduce package functions within two diverse stages such as Map as well as Reduce. The overall mapping jobs deal with the breaking as well as mapping of entire datasets while reducing the jobs shuffle as well as minimization of the entire data for effective segregation of a large amount of the datasets.

Data Collection

The researchers described motivational illustrations of utilizing the suggested scheme within this section. The author's main aim is to provide higher secrecy in big datasets D2D communication environments specifically when a huge amount of dataset handling becomes more difficult and challenging in the modern era. The entire implementation, as well as the verification scenario, is described as follows. There have been identified four kinds of diverse datasets packages which are categorized as D1, D2, D3, and D4. Every dataset comprises a diverse volume of datasets packages as well as the time of proper execution in real-time. There have been considered diverse cases for encrypting the datasets for effective D2D communication. For instance, when all D1 to D4 is zero that means no encryption of the dataset is done. Whenever one D1 value is 1, in such case 1, D1 encryption is done. Further, when all, D1, D2, D3, and D4 value is 1 in such case all encryption is done. Table 1 illustrates the dataset alternative procedure in the proposed scheme.

Pseudo Code

In this work, the authors majorly focused on the big data sets' secrecy as well confidentiality in the D2D communication environment. For obtaining the desired secrecy the authors developed a novel scheme that is more effective for maintaining the required secrecy level of the big datasets in real-time D2D communication. The authors focused on creating a framework for ultimate secrecy maintenance of the large volume of the datasets corresponding with secrecy needs as well as diverse timing constraints in a more efficient manner. The main outcome is the big datasets encryption plan FP ← 0 which is directing how a datasets package requires to be encrypted in minimal time as well as in less computing complexity when implemented in real-time application. The step of our developed algorithm is described as follows.

Step 1: Input FTc, FTm

Step 2: Initialize FP ← 0

Step 3: $FT_s \leftarrow \left[FT_s - \left(FT_m + \sum_{FDi \in FS\ Table} FN_{FDi}^{Fn} \times FT_{FDi}^{Fn}\right) + \sum_{FDi \in \{FW_{Di=0}\}} FN_{FDi}^{Fn} \times FT_{FDi}^{Fn}\right]$

Step 4: while FS table not vacant do

Step 5: Obtain FD_i having top primacy via FS Table

Step 6: for $\forall FD_i$, i=0 to FN_{Di} do

Step 7: if $FT_s > FT_{FDi}^{Fe} - FT_{FDi}^{Fn}$, then

Step 8: Addition of 1, FDi to FP

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Step 9: $FT_s \leftarrow FT_s - \left(FT_{FDi}^{Fe} - FT_{FDi}^{Fn}\right)$

Step 10: else

Step 11:Break

Step 12: end if

Step 13:end for

Step 14: end while

Step 15: Outcome FP

RESULTS AND DISCUSSION

The confidentiality, as well as desired secrecy of the big datasets handling, is becoming a massive threat, especially in the D2D communication environment. In recent years, diverse investigators developed multiple approaches for protecting the datasets in D2D communication against numerous kinds of assaults over the channels. However, these kinds of existing approaches have multifarious drawbacks in the modern D2D communication infrastructure and require more novel approaches for protecting the data sets more efficiently. For resolving these major threats in the real world the authors investigated and developed a novel scheme for implementation and security verification of a hybrid model for big data privacy-preserving in D2Dcommunication. The authors described the overall experiment evaluations within this section. The researchers initially established the trial setup rooted in the lab settings effectively. Initially, the authors modeled the simulation environment for performing the simulation procedure, and based upon that entire performance evaluation has been done with greater accuracy as well as precision for avoiding the chances of any errors. In this work, enhanced AES algorithms have been utilized for the big datasets D2D communication. Furthermore, the required cloud environment has indeed been created within the laboratory for handling and utilization of the multiple huge volume datasets in numerous trails in real-time for secrecy verification of big data in a D2D environment.

Additionally, researchers assessed the effectiveness of their proposed approach from diverse two viewpoints, including the degree of privacy preservation as well as computational effectiveness. Our trial conditions, which included several setups for achieving the anticipated assessment objectives, were in keeping with those diverse two elements. Through setting up varying numbers of datasets packets as well as the datasets encryption processing duration for every packet, researchers were able to simulate various kinds of workloads levels for the datasets transfer. Researchers rated several datasets packets with various security weights to assess the overall capacity to safeguard information. Additionally, to evaluate the effectiveness of optimum remedy takeovers, researchers employed an enhanced AES technique to get the outcomes of the optimum solutions. The overall trial setup information is described as follows.

Trial 1: The authors assessed the datasets packets volume from 1 to 7 initially. The time of encryption was considered among 4 to 10 units. Furthermore, the secrecy weighted amount for every dataset packet was considered from 1 to 7 initially.

Trial 2: The authors assessed the datasets packets volume from 1 to 8 initially. The time of encryption was considered among 3 to 15 units. Furthermore, the secrecy weighted amount for every dataset packet was considered from 1 to 8 initially.

Trial 3: The authors assessed the datasets packets volume from 1 to 9 initially. The time of encryption was considered among 2 to 20 units. Furthermore, the secrecy weighted amount for every dataset packet was considered from 1 to 9 initially.

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Trial 4: The authors assessed the datasets packets volume from 1 to 10 initially. The time of encryption was considered among 1 to 30 units. Furthermore, the secrecy weighted amount for every dataset packet was considered from 1 to10 initially.

Figure 3 illustrates the overall measured optimum privacy weight of the proposed scheme for data secrecy in D2D communication in seven rounds in the first trial. The overall measured optimum weight of the proposed scheme in the first trial and from 1 to 7 rounds was measured 110, 112, 118, 126, 128, 130, and 126 respectively. While in the case of S. O. Ogundoyin[23] scheme the measured weights were 100, 90, 85, 80, 75, 70, and 60, respectively. The measured outcome demonstrates that our scheme offers optimum and improved parametric values in comparison to the previous scheme.

Figure 4 illustrates the overall measured optimum privacy weight of the proposed scheme for data secrecy in D2D communication in seven rounds in the second trial. The overall measured optimum weight of the proposed scheme in the second trial and from 1 to 8 rounds was measured 114, 117, 120, 128, 134, 136, 138, and 145 respectively. While in the case of S. O. Ogundoyin[23] scheme the measured weights were 95, 89, 80, 78, 73, 65, 60, and 57, respectively. The measured results show that, when compared to the prior method, ours provides optimal and enhanced parametric values.

Figure 5 illustrates the overall measured optimum privacy weight of the proposed scheme for data secrecy in D2D communication in seven rounds in the third trial. The overall measured optimum weight of the proposed scheme in the third trial and from 1 to 9 rounds was measured 113, 118, 124, 129, 135, 138, 140, 142, and 145 respectively. While in the case of S. O. Ogundoyin [23] scheme the measured weights were 94, 89, 84, 79, 74, 69, 64, 59, and 54 respectively. The observed finding reveals that, in contrast to the prior scheme, our strategy gives optimal as well as enhanced parametric values.

Figure 6 illustrates the overall measured optimum privacy weight of the proposed scheme for data secrecy in D2D communication in seven rounds in the fourth trial. The overall measured optimum weight of the proposed scheme in the fourth trial and from 1 to 10 rounds was measured 115, 119, 127, 136, 143, 146, 148, 149, 150, and 152, respectively. While in case of S. O. Ogundoyi[23] scheme the measured weights were 92, 88, 84, 80, 76, 72, 68, 64, 60, and 56, respectively. These same assessed results indicated that, in contrast to the prior methodology, our approach delivers optimal but also more enhanced parametric values.

CONCLUSION

Nowadays optimal datasets secrecy has become one of the major threats in modern D2D telecommunication infrastructure because of huge traffic over the finite bandwidth channels. Due to the huge amount of datasets translation into day-to-day lives, the possibility of information leakage is increasing and demanding more attention towards novel approaches and pragmatic solutions. In this article, the authors developed a new scheme for implementation and security verification of a hybrid model for big data privacy-preserving in the D2D communication environment. In this work, the authors utilized the most recognized enhanced AES algorithm for the dataset's encryption in real-time. The overall measured optimum weight of the proposed scheme in the second trial and from 1 to 8 rounds was measured 114, 117, 120, 128, 134, 136, 138, and 145 respectively. The findings of the proposed schemes are enhanced and demonstrate that this is a well-suited scheme in the modern D2D communication scenario for maintaining the secrecy as well as privacy of the large datasets in a more effective manner and offers very minimal computing complexity. In recent years, several authors have worked in this area for improving the secrecy and privacy of big data translation in the D2D communication environment. However, due to extremely large datasets translation over finite bandwidth channels, there are diverse secrecy issues in modern communication infra structure, therefore there is a huge scope and need for future research in this arena.

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Table 1: Illustrates the dataset alternative procedure in the proposed scheme

Sl. No	D1	D2	D3	D4	Strategy
1.	0	0	0	0	No encryption
2.	1	0	0	0	1, D1 encryption
3.	2	0	0	0	2, D1 encryption
4.	0	2	1	0	2, D2 and 1, D3 encryption
5.	0	1	2	1	1, D2 and 2, D3 including 1 D4 encryption
6.	1	1	1	1	All, D1, D2, D3, and D4 encryption
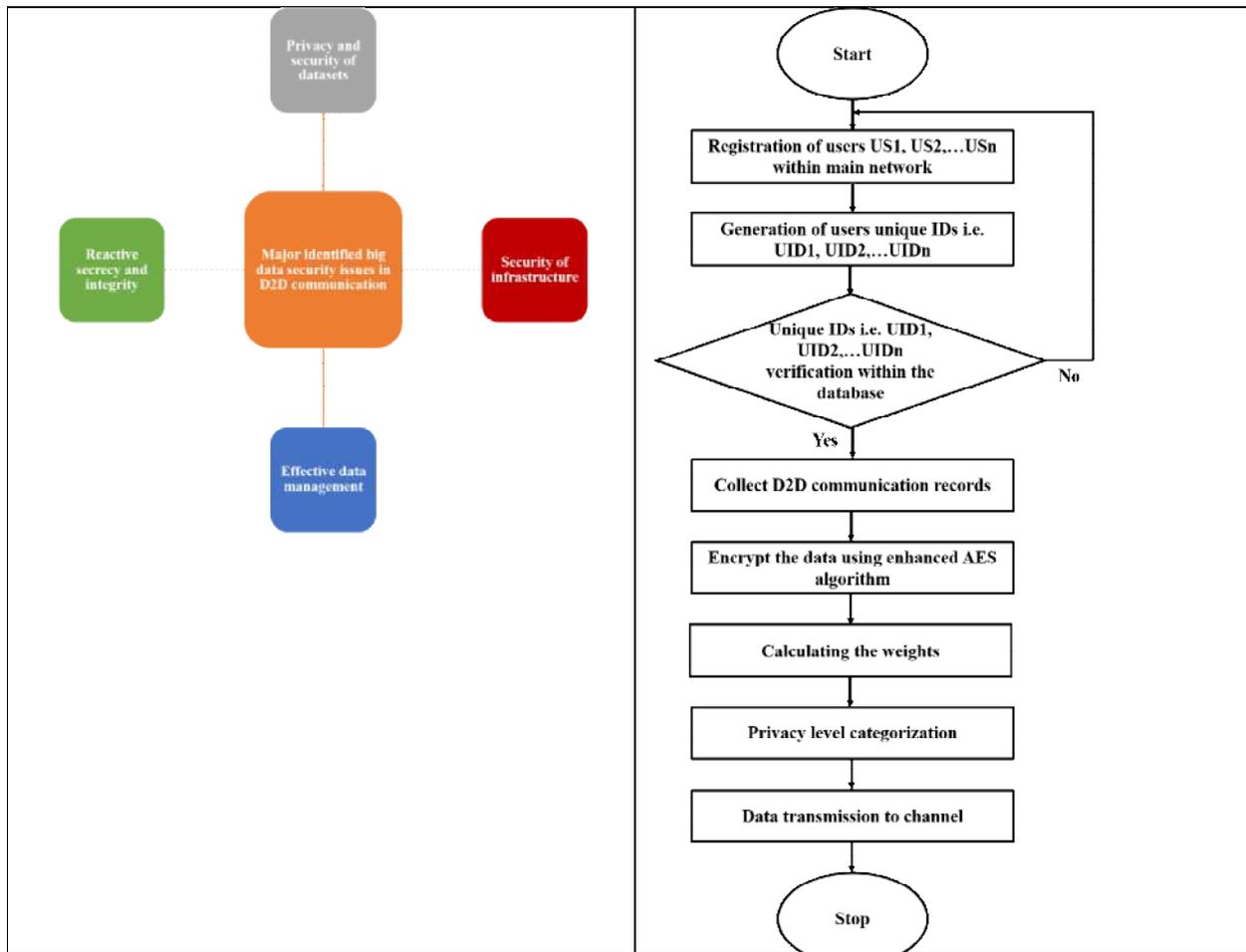
| **Figure 1: Demonstrates the major identified big data secrecy-related threats in the D2D communication environment** | **Figure 2: Illustrates the flow diagram of our proposed scheme for security verification of the Hybrid Model for Big Data Privacy-Preserving in D2D Communication.** |

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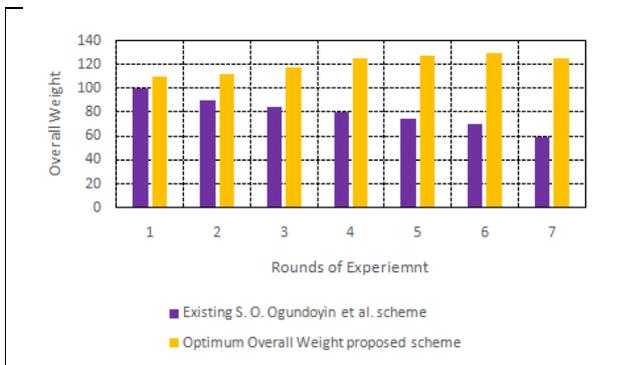
Figure 3: Illustrates the overall measured optimum privacy weight of the proposed scheme for data secrecy in D2D communication in seven rounds in the first trial.
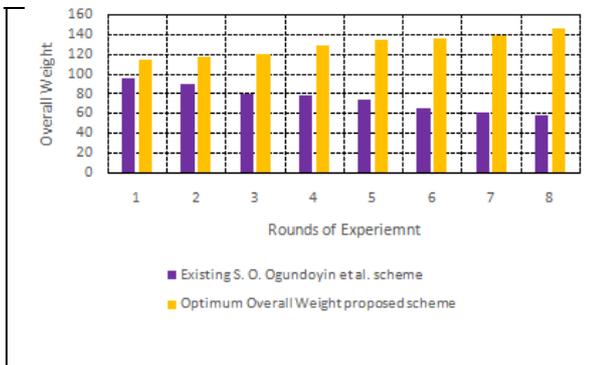
Figure 4: Illustrates the overall measured optimum privacy weight of the proposed scheme for data secrecy in D2D communication in eight rounds in the second trial.
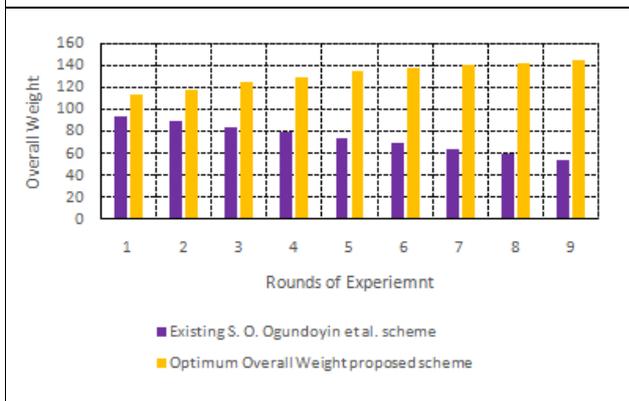
Figure 5: Illustrates the overall measured optimum privacy weight of the proposed scheme for data secrecy in D2D communication in nine rounds in the third trial.
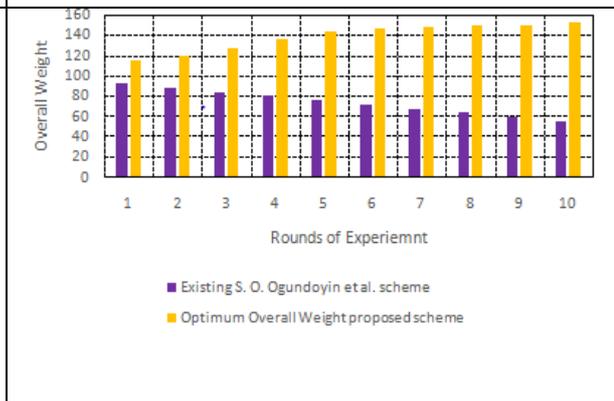
Figure 6: Illustrates the overall measured optimum privacy weight of the proposed scheme for data secrecy in D2D communication in ten rounds in the fourth trial.

REVIEW ARTICLE

Predicting Postpartum Depression with Machine Learning: A Systematic Review and Meta-Analysis

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ABSTRACT

Postpartum depression (PPD) is one of the most common maternal morbidities after delivery adversely affecting the well-being of mothers and their new-borns.PPD symptoms results in negative association between mother-baby bonding, severely affects infant cognitive development, language, behaviors, sleep quality, physical-mental health of both mother and children. In extreme cases, maternal suicide and infanticide thought might frequently occur in depressed mothers. PPD is a frequently overlooked health issue requiring timely and early-stage treatment to prevent serious complications. In recent years, Machine Learning (ML) models are increasingly used in healthcare particularly in psychiatry prediction to improve patient health status. ML models are specifically applied to support medical personnel in the prediction of PPD for pregnant mothers using electronic health data (EHD) to improve management of the condition. It is well-known for its ability to analyze vast quantities of data and estimate PPD probability which help the physicians in decision-making and early diagnosis of disorder. This this paper presents a detailed review of various ML frameworks developed to predict PPD and categorize PPD disorder from EHD data. First, different PPD disorder recognition models designed by many researchers based on ML algorithms are studied in brief. Then, a comparative study is conducted to understand the drawbacks of those algorithms and suggest a new solution to classify the PPD disorder accurately at its earlier phase to reduce the morality rate and improve the health status of mother and children.

Keywords: Postpartum depression, Electronic Health Data, Electronic Health Data, Machine Learning, Psychiatry Prediction

INTRODUCTION

Pregnancy and childbirth are significant life events for women. These transitory life events have very great impact onmother's physical and mental health, this condition is termed as Postpartum Depression (PPD) [1]. PPD is a serious public health problem that accounts for more than 24% of all postpartum fatalities, making it the most prevalent reason for mother perinatal mortality. PPD not only adversely affects the physical and mental health of mothers, it is detrimental to the growth and development of infants [2]. PPD symptoms have also been linked to poor mother-baby bonding, newborn physical and cognitive development, language development, infant behaviors, and sleep quality [3]. Childbirth significantly exposes women to many mental diseases, with PPD being the leading cause of postpartum haemorrhage in the body [4]. Clinical symptoms of PPD such as difficulty falling or staying asleep, prolonged sleeping, fluctuations in mood, loss of appetite, dread of hurting someone, severe worry about the baby, sadness or excessive crying, feelings of guilt and hopelessness, difficulty concentrating and recollecting, absence of desire in interests and daily activities, suicidal thoughts, and persistent thoughts of suicide are some of the notable actions of the delivered mother [5]. The earlier prevention of PPD will reduce the morality rate and enhances the physical-mental health of the mother and the well-being of the infants

It is well-accepted that intervention by either pharmacological treatment or psychological counseling might reduce the risk of perinatal depression and may improve the outcomes of both mother and child, however the safety of exposure to antidepressant medications during pregnancy and breastfeeding is still a challenging part [6-7]. Although the risk factors of PPD are well-known, there are no quantitative risk assessment tools to support the screening and clinical management of women during perinatal period. Electronic health records (EHR) from primary care services provide rich representation of the patient's medical condition, including diagnoses, drug prescriptions, procedures and lab tests. This information along with the patient's socio-demographic background are a useful source of information for estimating risk and predicting disease [8-9]. The physiological questionnaire Edinburgh Postnatal Depression Scale (EPDS) is frequently used by psychiatrist or doctors to diagnose PPD [10]. The EPDS data were collected from delivered mothers for one week, the score was evaluated by medical experts, and participants with PDD symptoms were identified. As a part of multistage progress follow-up was carried out by collecting the Patient Health Questionnaire-9 (PHQ-9), Postpartum Depression Screening Scale (PDSS) questionnaires for the above-predicted participants until six weeks [11]. The EPDS screening focuses on postpartum mood disorder and ignores anxiety, irritability and other symptoms that have been found to be common among women, especially during reproductive-related times [12]. However, demographic statistics or social support information are not taken into account in EPDS evaluation. This may lead to concerns that EPDS may not detect a wide range of pre- and postpartum symptoms and illnesses. Additionally, the EPDS has a lower positive predictive value in normal populations compared to validation study populations.

In recent time, Machine Learning (ML) plays an important role to predict PPD at its earlier stage. ML models are hypothesized with efficient data interpretation, précised decision making, provides accurate psychiatry care, focusing on the progression of PPD over time and effectively distinguishing different PPD stages [13]. ML algorithms include Support Vector Machines (SVMs), Genetic Algorithm (GA), K-Nearest Neighbour (KNN) Random Forest (RF), Navies Bayes (NB) Artificial Neural Networks (ANNs), Decision Tree (DT), Bayesian Networks (BNs) and so on. These algorithms aim to identify the data correlations from the complex patterns, benefits to provide automated tasks for developing new hypothesis [14]. Furthermore, ML models are effective at categorizing the large EHR data with less computational problems, reducing long procedure times, numerous measurement values, complicated analyses, personalised evaluations, operator subjectivity, and broad observation ranges. It also successfully used in psychiatry to predict major depressive disorder persistence, chronicity, severity, and treatment response [15].

The aim of this study is to provide a complete survey of various ML models and their applications in recognizing the PPD for enhancing the early prediction rate and reduces the morality rate. Also, a comparative study is presented to address the advantages and disadvantages of those models to suggest future scope. The rest of the sections are

prepared as follows: Section II discusses various models designed to detect and classify the PPD using EHR data. Section III provides the comparative analysis of those models. Section IV summarizes the entire study and suggests the upcoming scope.

Survey on Post Partum Depression Prediction Using Machine Learning Model

Jiménez-Serrano *et al*. [16] developed a mobile health application to predict PPD based on ML model. Initially, mobile health app was developed for android platforms using model's best performance for mothers and clinicians monitoring their patients' tests. The models were trained using ML techniques with an internal evaluation using a hold-out strategy predict postpartum depression (PPD) during the first week after childbirth with a reasonable accuracy. Fatima *et al*. [17] constructed a ML model for PPD prediction from social media text. Initially, the linguistic features were extracted using linguistic inquiry word count (LIWC) from the social media. Then, two layers were constructed to distinguish PPD from non-PPD depressive posts. In the first layer, general and depressive discussion were categorized. In the second layer, PPD and non-PPD depressive posts were segregated. Finally, the SVM and LR method effectively predict depressive content (PPD + non-PPD) and bifurcate PPD and non-PPD content using the same feature set which provides robust PPD prediction capabilities.

Betts *et al*. [18] presented a prediction model to identify women at risk of postpartum psychiatric admission. The dataset was collected, pre-processed and normalized. The pre-processed were given as input to the various ML models ton predict the hospital admission following the delivery in which the primary diagnosis was recorded as apsychotic depressive disorder. The LR and elastic net model to identify mothers at risk of postpartum psychiatric admission for early treatment task. Shin *et al*. [19] developed a predictive model for PPD depression using ML model. A retrospective cohort study using data from the pregnancy risk assessment monitoring system. The imbalance between the two groups were evaluated by a balanced resampling using both random down-sampling and the synthetic minority over-sampling technique. The ML was utilized RF, stochastic gradient boosting, SVM, NB, kNN, LR were employed to identify the postpartum depression. Zhang *et al*. [20] constructed a ML model for PPD prediction based on a cohort study. The EPDS was used to collect the data based on their psychological score. Then, the random forest-based filter feature selection (FFS-RF) were employed to select the features within a certain bound value range potential predictors and incorporated into the final prediction model. Finally, the SVM and RF was adopted for the PPD prediction.

Hochman *et al*. [21] developed a ML model for PPD prediction. In this method, gradient-boosted DT algorithm was applied to EHR data to obtain the clinical features. The features were incorporated into the ML model for automatic and risk analysis for early PPD prediction tasks. Andersson *et al*. [22] developed a predicting woman with depressive symptoms postpartum with ML using clinical, demographic and psychometric data from postpartum questionnaires. The collected dataset waspre-processed and normalized using KNN model. Then the obtained data was given as input to the ML model to predict the depressive postpartum depression. Amit *et al*. [23] suggested a PPD risk detection model using ML model. This model allowed for early alert of PPD and analyzes the risk prior to pregnancy. It analyzes the subjective and accuracy of the screening tasks which enables timely interventions and consequently applied to improved health status of the mother and child health. The evaluation of timely interventions helps the early alert status of PPD and prevents the risk prior to pregnancy.

Zhang *et al*. [24] utilized a ML model for predicting the risk of PPD among pregnant women. In this method, the EHR data was collected, pre-processed and normalized. The structured query and natural language processing (NLP) was employed to select the minimal list of features from the datasets. Finally, different ML model like RF, DT, LR, XGboostand multilayer perceptron (MLP) were adopted to detect collective patterns across features that maximally discriminate outcome classes for PPD detection. Raisa *et al*. [25] constructed a ML approach for early detection of PPD in bangladesh. The survey on various socio-demographic questions and EPDS data was collected, pre-processed and augmented using synthetic minority oversampling approach (SMOTE). The SMOTE provides synthetic members based on the euclidean distances between data points in feature space. Finally, SVM, RF, LR and XGBoost were employed for the for PPD detection.

Wakefield and Frasch [26] created an ML model based on antepartum EHR data for patients who needed PPD therapy Four ML models were generated and optimized using the distributed RF model. Model 1 adopted itself with publicly available socio demographic variables. Model 2 includes mother mental health data prior to pregnancy. Model 3 used recursive feature removal to develop a compact and cost-effective model. Model 4 titrated the input data further to eliminate pre-pregnancy mental health factors for PPD detection.

Gopalakrishnan *et al*. [27] constructed a ML model for the prediction of PPD. Initially, the data was collected and then it was divided into EPDS and Background Information (BI) of pregnancy women. The RF model was employed to select the relevant features. The selected features were fed into lasso regression model to predict the risk factors and forecast the prevalence of PPD symptoms. Prabhashwareem *et al*. [28] developed a ML model for predicting mothers with PPD. The collected data consists of mother's family, social background, and other data-related status which was pre-processed and normalized using Min-Max normalization. The obtained data was fed into Feed-Forward Neural Network (FFANN), Adaptive Neuro-Fuzzy Inference System with Genetic Algorithm (ANFIS - GA), RF and SVM for the prediction of PPD risk levels. Rousseau *et al*. [29] suggested a ML model to identify the pregnant women's risk for persistent post-traumatic stress following childbirth (PTS-FC). From the collected data, women's profiles were categorized into Stable-High-PTS-FC and Stable-Low-PTS-FC using the latent class evaluation. Then, the DT was employed to identify women at risk for Stable-High PTS-FC for early prediction.

Huang *et al*. [30] developed a prenatal depression and assessing model bias using ML model. The EHR data was collected from large urban city hospital. The collected data was pre-processed and normalized using min-max normalization. Then, Shapley Additive Explanations (SHAP) was employed to interpret the data. Moreover, the disparate impact (DI) and equal opportunity difference (EOD) was employed to assess the model bias. The interpreted data would be fed into elastic net to classify and predict different stages of PPD. Wakefield and Frasch [31] presented a method for detecting PPD using EHR data. In this method, four ML models were created and optimized using distributed RF and the logistic regression (LR) model. The model 1 relied only on easily accessible socio-demographic data. Model 2 includes mother mental health data prior to pregnancy. Model 3 used recursive feature removal to create a compact model. Model 4 calibrated the input data further in order to simplify pre-pregnancy mental health factors. Finally, the LR model was employed the identical input data as Model 3 for the final prediction of PPD. Liu *et al*. [32] presented an optimization ML model for PPD risk assessment and preventive intervention strategy. In this method, the EHR data of parturients that underwent a cesarean delivery was collected and pre-processed. The SHAP was employed for the data interpretation. The propensity score matching (PSM) was developed to compare the incidence of PPD between training and testing groups for differentiating PPD with high or low risk symptoms. Finally, the obtained features were given as input to the XG Boost which provides early intervention for the high-risk groups for the effective PPD prediction.

Compartive Analysis
In this part, a comparative study is presented according to the benefits and drawbacks of PPD prediction models by utilizing different ML methods whichare briefly studied in above section and the comparison is provided in below table 1. From the above table, the article [16-32] is studied and it is concluded that the article [27] yields better detection result for PPD detection and classification derived from the EHR data using various ML model. In the article [27],the data collection and statistical analysis for examining the link between risk factors and PPD symptoms were analyzed through for the early prediction task. Demographic information, EPDS, PDSS, and PHQ-9 screening tests were used to identify PPD risk variables in a distributed survey. Screenings were conducted one week to six weeks after delivery. During the initial phase, questionnaire scores were calculated to identify emerging cases of depression. If an EPDS result was affirmative, a woman's PHQ-9 and PDSS questionnaires were assessed in the second stage to reduce misdiagnosis. Then, collected data was pre-processed and the features were selected using the RF model. The collected data was fed into multiple ML models and lasso regression models, yielding high accuracy results for PPD detection and classification enabling early prediction.

CONCLUSION

PPD is a severe health concern which significantly impacts maternal and neonatal health. The development of an automated predictive model for early diagnosis of PPD is crucial to manage the morality rate. ML models are effective in identifying at-risk patients postpartum using HER datawith low complexity challenges. In this paper, a comprehensive review on different ML methods for detecting the PPD using EHR data according to their strengths, weaknesses and prediction efficiencies are provided. The discussed challenges and performances are key access for the researchers to develop fully functional models that could help in improving in PPD prediction and diagnosis and provides ultimately personalized treatments for new mothers and their infants. So, Future work focuses on developing advanced computation models for fast mobile applications to provide real-time point-of-care diagnosis and clinical decision support systems for the consistent health status monitoring of PPD patients.

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Table. 1 Comparison of different ML associated PPD models

Ref no	Technique	Advantages	Disadvantages	Performance Evaluation
[16]	ML model	Rapid interpretation Culturally Sensitive and cost-effective	It provides lower result on larger dataset	Accuracy = 0.79; Sensitivity = 0.53; Specificity = 0.83; AUC = 0.66
[17]	LIWC, SVM, LR	It works well on larger data and provides consistent result throughout the prediction experiment	Easy prone to noise and vulnerability factors which enhances the classification error	Accuracy for depressive content identification = 91.7%; Accuracy for PPD content Prediction = 86.9%
[18]	LR, Elastic net model	Less computational cost and time	It takes long time to train the model	AUC- Receiver Operating Curve (ROC) =
[19]	RF, stochastic gradient boosting, SVM, NB, kNN, LR	Lower computational complexity and generalizability error	The data interpretation was difficult and lower convergence rate	Accuracy = 0.650; Precision = 0.649; Sensitivity = 0.650; F1-Score = 0.651 AUC = 0.864
[20]	FFS-RF, SVM	Lower classification error and better data interpretation	Lower efficiency as it was trained with smaller data size	Sensitivity = 0.69; AUC = 0.78
[21]	Gradient-boosted DT	It efficiently works on large sample size	Lower generalizability and scalability	AUROC = 0.712; Sensitivity = 0.69; Specificity = 0.91
[22]	ML model	High Generalizability and easy interpretability	This method results in high uncertainty issues	Accuracy = 73%; Sensitivity = 72%; Specificity = 75%; AUC = 81%
[23]	ML model	Better convergence rate and quantitative risk estimation	High misclassification error and easy prone to noisy data	AUC = 0.844; Sensitivity= 0.76; Specificity = 0.80.
[24]	NLP, RF, DT, LR, MLP, XG-Boost	Timely prevention, lower negative outcomes computational burden	High loss of information and lack of comprehensive screening of data	AUC = 0.912; Sensitivity = 0.80; Specificity = 0.79
[25]	SMOTE, SVM, RF, LR and XGBoost	High scalability on larger dataset and lower computational cost	Inappropriate biasselectionand trained with limited data samples .	Accuracy = 85%; Sensitivity = 84.4%; Precision = 85.2%; F1-Score = 84.4% AUC = 92.4%;
[26]	Distributed RF	Efficient convergence rate and scalability	Unbalanced sample distribution in the dataset may affect the performance rate	AUC = 0.91; Sensitivity = 0.68
[27]	RF, Lasso regression	Reduces the overfitting issues and less time	High class disparity makes it difficult to train the model	AUC = 78; Accuracy = 71%;

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		complexity		Sensitivity = 56%; Specificity = 86%;
[28]	FFANN, ANFIS – GA, RF and SVM	High appropriate and timely response with stable performances	Insufficient data samples lead to degrade the performance.	Accuracy = 95%; Testing error rate = 0.0600; Sensitivity = 94%
[29]	Decision tree, latent class evaluation	This model reduces the bias selection and uncertainty issues	Increase in the data, increases the complexities	Accuracy = 80.6%
[30]	SHAP, DI, EOD, Elastic-Net	Effective removes the model's bias and robust to noisy data	Failed to extract the optimal features subset to enhance the accuracy and reduce misclassified instances	ROCAUC = 0.75; Sensitivity = 80%;
[31]	Distributed RF and LR	Lower complexity and robust to uncertainty issues	The model's performance was notably lower due to its training on a limited dataset.	AUC = 0.93; Sensitivity = 0.71
[32]	XGBoost	Better execution time and convergence rate	It takes long time to train the model	AUROC = 0.789; PPD risk probability = 21.5%
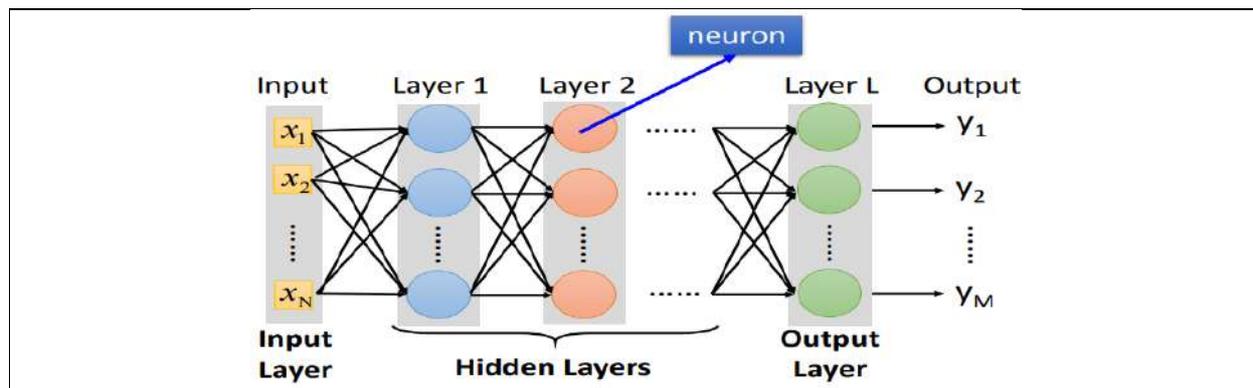
Figure 1 Machine learning Architecture
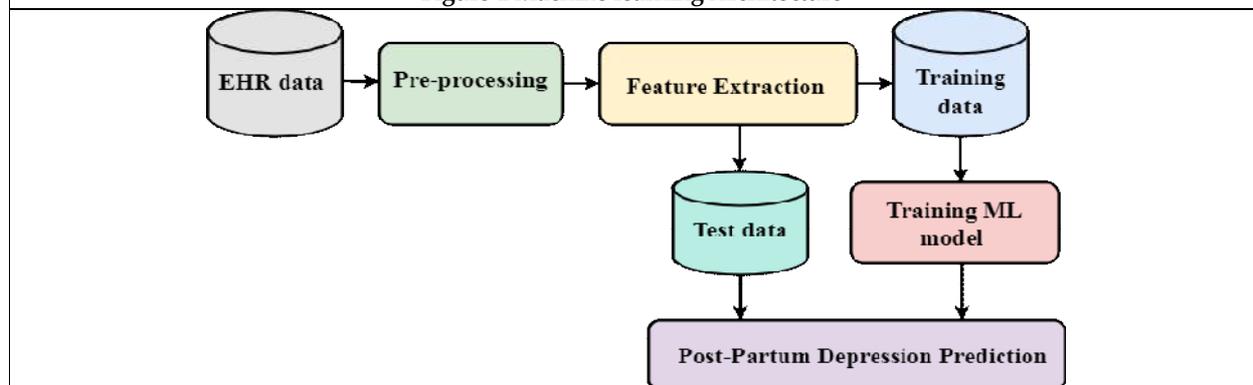
Figure 2 Basic model of PPD prediction using ML model

REVIEW ARTICLE

Performance Analysis Review of Different Controllers Employed in Brushless DC Motor

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ABSTRACT

This review document provides a brief overview of the performance analysis on different control techniques when applied to the brushless DC motor (BLDCM). These types of motors are non-linear in nature, therefore conventional controllers (PI, PID) do not achieve the desired steady-state performance. To achieve the control objective, intelligent controllers are presented with such a scheme according to various other control techniques such as (PI, PID, Fuzzy, ANN, Hybrid Adaptive Fuzzy, Neural-Fuzzy, Hybrid Neuro-Fuzzy, diffuse scrolling mode, MRAC, FPIDSMC and FSMC) were investigated by several researcher .These techniques differ in several ways, such as control architecture, controller adjustment method, dynamic and steady-state performance. The document presents a comparative review of the performance analysis of conventional and intelligent control techniques.

Keywords: BLDC motor, PI,PID, Fuzzy, ANN, Hybrid Adaptive Fuzzy, Neural-Fuzzy, Hybrid Neuro-Fuzzy, sliding mode fuzzy, MRAC, FPIDSMC and FSMC.

INTRODUCTION

A permanent magnet (PM) synchronous motor with trapezoidal induced voltage waveform is called a BLDC motor. A BLDC motor is activated electronically rather than mechanically based on feedback on the rotor position. The rotor

of the BLDC motor contains permanent magnets and the stator has a winding. Rotor position detected by sensors positioned internally or externally. The BLDC motor is the most popular for various industrial applications (90% closed loop control with PI, PID thanks to the intrinsic advantage of simple structure and robust operation), robotics, avionics thanks to its high torque speed characteristics, less noise and less maintenance [1] Feedback is based on the sensor or not on the sensor. position sensors as feedback with this the parameter changes are temperature, pressure with the system with parameter changes are affected [2]. So the sensorless rotor position detection system [3] has received more and more attention. The sensorless method mainly includes the post EMF method, the Flux Linkage based method. But this controller is not suitable for the BLDC motor due to the non-linear behavior of the variations of the system parameters in different load conditions of the BLDC motor, the researcher proposed different techniques (hybrid, intelligent and robust controllers). The compensated system designed using the non-iterative controller design approach provides the desired specifications with greater precision for the different BLDC drive systems. The transient response of the compensated system is better than that obtained using the conventional design approach [4]. Fuzzy Sliding Mode Control with PID Compensator [5] introduced for BLDCM, this method features a robust control system with the Fuzzy Sliding Mode Controller and an additional compensator. FPIDSMC and FSMC controllers can provide robustness to external uncertainties and disturbances, FPIDSMC offers better performance than FSMC compared to the external load torque, vibrations are avoided and the system response is improved. Complete analysis of the fuzzy logic controller for PMBDCMD presented for a fast dynamic response such as speed and torque in a short time in case of sudden changes or load disturbances [6].

The adaptive diffuse control method is used with sliding mode control algorithms. AFSMC performance is generating free phenomena and system stability will be improved compared to conventional sliding mode control to reduce the vibration of the nearby sliding surface [7]. The Intelligent Brain Emotional Learning Based Controller (BELBIC) is adapted for BLDCM. BELBIC's high level of precise self-learning offers fast and fast responses at transient speeds in a wide range of speeds from 20 to 300 rpm. Good monitoring has excellent control performance, good robustness and adaptability [8]. In [9] A comparison between DC motor position control by a PIDSMC fractional diffuse surface and a PIDSMC diffuse surface clearly shows that FPIDSMC offers better performance than PIDSMC compared to the external load torque. It is a robust controller and vibrations against external load torque are avoided. In [10] a fractional order derivative and a proportional controller (FOPD) is proposed for typical second order plants. The closed circuit system can achieve favorable dynamic performance and robustness compared to other techniques. A PI Fuzzy Gain Scheduling (FGSPIC) controller is proposed for BLDCM, three separate PI controllers for different low, medium and high speed sampling time intervals. , robust in a variable sampling situation (different loading conditions) [11]. A comparative study between PI, fuzzy and hybrid PI-Fuzzy controller (the hybrid controller has integrated both the diffuse controller and the PI controller) for speed control of the brushless DC motor (BLDC) ", a diffuse controller offers a better response starting speed while PI The controller has a good compliance with respect to the variation of the load torque, but the hybrid controller has the advantage of integrating the superiority of these two controllers to improve the performance of the control. The PI has a good load torque but a slow tuning response Shorter settling time The hybrid driver has integrated both the fuzzy driver and the PI driver During a high-speed error, the hybrid driver has improved the dynamic performance of the BLDC Motor [12] A speed controller intelligent for brushless DC motor with this PID method and PID controller of Fuse to control the BLDCM speed proposed FPID controller performs better than the conventional PID controller, when the engine undergoes sudden changes at ever higher speeds. The speed of the motor that must be kept constant during a sudden load varies with the fuzzy PID controller, but with the PID controller adjustment it is the problem that FPIDC can overcome [13].

In [14] the design of a BLDCM speed control using the PIC16F877A microcontroller. variation under load. By varying the PWM signal from the microcontroller to the motor controller, it is possible to control the motor speed and also the performance analysis of a BLDCM drive speed with PI and a diffuse-based controller. The dynamic behavior of the fuzzy logic controller provides a much better dynamic response and is robust. The fuzzy logic controller offers a better response than the PI controller. A cascade SMCNRPID controller for BLDCMD is proposed for better performance than the conventional PID controller. It reveals excellent performance in the treatment of overdrive,

under drive and settling times, SMCNRPID reduces vibrations when the system is moved on a sliding surface [15]. A cascaded SMCNRPID controller shows a faster and vibration-free response to pitch disturbances, has more robust features than the conventional PID controller [16]. For BLDCM (BLDC motor) a robust diffuse neural control is proposed. the control signal includes diffuse neural control, supervised control and error states. The regulation laws for network parameters are from Lyapunov's theorem for network convergence and stability. The proposed controller was run on a TMS320F2812 DSP. It is feasible and effective even under variable load conditions [17]. In [18] a fuzzy estimator is proposed for driving the PMBLDC motor without reverse speed sensor. In this method the conventional sensorless method and the fuzzy estimate of electromagnetic fields are compared. The algorithm proposed using the fuzzy EMF estimator obtains robust control for the change of an external condition and continuously estimates the rotor speed in transient and steady state conditions. The proposed sensorless drive method without additional circuit has superior performance compared to conventional sensorless methods.

In [19] direct torque control based on the Fuzzy Logic Controller has been demonstrated. DTC has some advantages such as a simple and easy to implement algorithm, a faster torque response, a reduced torque fluctuation and a lower sensitivity to parameter changes, which is why the system has used DTC methods to eliminate the exceeding responses of speed and torque. PI controller compared to Fuzzy Logic controller. The effectiveness of the FLC controller is greater than other controllers. PI controller replaced by FLC. Using Fuzzy Logic Control, the starting current was reduced due to the reliability of the FLC controller. The effectiveness of the FLC controller was verified by simulation. In [20] Modeling and control of BLDC three-phase motors by means of PID with genetic algorithm for BLDCM. In this paper, conventionally tuned PID controllers and genetic algorithm are proposed as a global optimizer for finding optimized PID gains for BLDC motor position control. A comparative analysis with GA and ZIEGLER NICHOLS METHOD (ZNM). Controller performance with GA optimized gains are much more efficient than the ZN method in terms of rise time, settling time, overshoot and set point detection. But ZNM provides the initial values of the PID gains for GA optimization. [21] Modeling and simulation of BLDC motors in the MATLAB GUI presented for various types of BLDC motors that minimize torque ripple. Performance evaluation leads to very useful modeling to study the drive system before starting the design of the dedicated controller, taking into account the relevant dynamic motor parameters. [22] The BLDC motor drive system with sensorless control that uses the Adaptive Neuro Fuzzy Inference (ANFIS) system algorithm for BLDCM, the algorithm consists of the Least Squared method in its forward path while its feedback path uses the posterior propagation method. The modeled BLDC drive system was subjected to the NeuroFuzzy adaptive inference system (ANFIS) for sensorless estimation in closed loop operation. This document examines the sensorless control of the BLDC motor. ANFIS is a very powerful approach to building a complex and nonlinear relationship between a set of inputs and outputs. In [23] A DTC technique for BLDCM with non-sinusoidal rear EMF presented for high torque response and minimization of torque ripple to drive BLDCM.

A slide observer design was proposed to estimate the trapezoidal EMF of a BLDC motor. It is robust due to the uncertainties of the parameters, it can be used to estimate the subsequent EMF and generate the torque. It is used to estimate the non-sinusoidal posterior EMF waveform in a BLDCM using only stator current measurements. A modified version of the non-dominated genetic classification algorithm (NSGA-II) is used as an effective optimization tool to adjust the speed controller PID controller parameters and the selection of four slider observer gains. The relationship between the PID controller and sliding mode is also satisfied with NSGA-II. The effectiveness of the proposed system was validated by the simulation results. In [24] The design of the Fuzzy PID controller for brushless DC motor has proposed lower, higher and constant speeds even when the load varies. a comparative study of the integral integral proportional controller (PID) and the integral integral proportional Fuzzy controller of the three-phase BLDC motor. The widespread PID controller has better control performance than the conventional PID controller when sudden load disturbance occurs. Conventional PID controller difficult to adjust parameters. Because Fuzzy tuning has the ability to satisfy control characteristics and is easy to calculate. The improved Fuzzy PID controller has superior PID control over the conventional.

In [25] Conventional and fuzzy PID controller with field programmable matrix (FPGA) proposed for BLDCM speed control. It was simulated and synthesized using the Xilinx Foundation package and implemented in the Xilinx XC3S400 FPGA. The dynamic response of the system using the proposed controller is better than a conventional controller. The proposed method provides several BLDCM speed commands with correct speed regulation. In [26], hybrid fuzzy control solutions for BLDC units with variable moment of inertia offer four Takagi-Sugeno hybrid fuzzy controllers consisting of two Neuro-diffuse PI hybrid controllers and two adaptive fuzzy sliding controllers. two hybrid PI-NFCs based on an online adaptation of a PI-FC and two ASMFCs based on online adaptation of the switching gain. First, the VMI is characteristic for many servo applications, it may be necessary to use controllers adapted to the operating point. Second, fuzzy control can offer advantageous nonlinear control solutions compared to other BLDCM control solutions. These control techniques and design methods expand the industrial application areas of BLDCM drives and are also implemented for other control applications. The control structures have robustness, system stability and offer constant performance in the presence of model uncertainties. In [27] a comparison of the performance of the PMBLDCM drive with the speed controller PI and FLC is proposed. FLC offers good results in terms of torque ripples and current control limits for windings. Low starting current is achieved if FLC is used, leading to a low cost reversing switch. the starting torque is reduced compared to the use of the PI controller, but does not cause starting problems. It can be easily applied to industrial applications where reliable and inexpensive operation of the BLOC motor drive is required. In [28], the conventional Slip Mode Observer (CSMO) and Enhanced Slip Mode Observer (ISMO) are proposed for BLDCM. The improved scroll mode observer eliminates the problem of unwanted vibrations in the conventional scroll mode observer. ISMO stability was verified by Lyapunov's stability analysis. The use of the sigmoid function in Sliding Mode Observer (SMO) allows to estimate the position of the rotor with high precision and to obtain a faster response. Enhanced Slider Mode Observer (ISMO) has good convergence and solid observer performance. In [29], the sensorless control of BLDC motors uses the closed circuit PWM controller.

An FPGA-based implementation of the BLDC FSTP unit that uses PWM control and real-time experiment. Hardware implementation is performed using the SPARTAN-3 processor. The VHDL (Very High Speed Description Language) program is developed in XILINX to generate the PWM pulses controlled to control the system. In [30] a sliding mode control algorithm (SMCA) is proposed for controlling the speed and current of a BLDC motor. The exponential approach of the flow law was used to design the flow laws for the mathematical model of the BLDC engine developed. An SMCA compared to an integral proportional controller (PIC). The scroll mode control offers much better performance in terms of steady state error, faster settling time, excessive speed response and elimination of the best noise rejection capabilities. but there is the Chattering effect. In [31] Reduction of torque ripple and increase of the torque capacity proposed for the BLDC motor. To increase the torque, the BLDC 9-phase motor model was studied and its efficiency and ripple reduction were tested by simulation. The comparison between the three-phase, 5-phase and 7-phase and 9-phase BLDCM models discussed and the effect of the increase in the number of phases shows that the starting torque of the motor will increase and the efficiency of the motor will also increase slightly. the torque ripple will decrease.

In [32] A Neuro-Fuzzy Hybrid (N.F.) - P.I. Proposed controller powered to control the speed of BLDC motors. A solid S.S.E.E. (removal of steady state errors) to enrich the entire control process. The hybrid system, P.I. N.F.C. is the main loop of the controller while the integral S.S.E.E. The controller reimburses steady state errors. In this he proposed the BLDC unit's capabilities for fast tracking, small steady-state errors and high stability despite all the load and parameter changes compared to other conventional controllers. In [33] Model of adaptive reference controller (MRAC) that uses an artificial neural network controller (ANN) proposed for brushless DC motors (BLDC). The MRAC-based model is capable of monitoring speed and reducing the effect of parameter changes under different conditions. BLDCM suitable for applications such as robotics and position detection. The MRAC-based model is able to monitor the speed and effect of parameter changes compared to the performance of the traditional PID controller. The proposed RNA-based control scheme is robust, efficient and easy to implement.

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In [34] the anti-roll PI controller and the fuzzy controller proposed for BLDC motor speed control. The comparison with the PI controller. Conventional PI controllers are slower than popular, anti-winding controllers. From the simulation results, it is clear that for the load variation, the PI windproof controller gave a better response than the conventional PI and the widespread controller. Therefore, the anti-roll PI controller proves more suitable to drive the BLDC motor during load variation. In [35], fuzzy tuning in PID sliding mode is proposed for the BLDCM drive system. The PIDSMFC-based BLDC motor drive system tracks the error and causes the actual speed to follow the reference speed when the system is subject to a gradual change in the reference speed, sudden load disturbance and parameter changes. The comparison between BLDC motor speed control from PIDSMFC and SMFC, that PIDSMFC offers better performance than SMFC compared to external load disturbances, so the controller is a robust controller, vibrations are avoided and the system response against load from external impact.

In [36] Fractional Order PI Controller (FOPI) proposed for BLDC Motor Drive. It is done with the Oustaloup filter. The desired response obtained by adjusting in 1 / S ^ . The FOPI controller tested on the BLDC motor for various operating modes and performance compared to the conventional PI controller. The performance of the FOPI controller is quite good with constant speed and constant torque mode compared to the conventional PI controller. In [37] The fractional order fuzzy logic controller (FOFLC) proposed for the BLDC motor. Controller performance tested under different operating conditions and sudden load disturbance. The performance of the FOFLC controller compared to the FOPI controller and the conventional PI controller. Torque, speed response are faster and smoother than the FOPI and PI controllers in terms of rise time, maximum exceedance and stabilization time. In [38] a sliding mode controller (FOSMC) was proposed to improve the dynamic performance of a BLDC motor.

The FOSMC has a robustness against external load disturbances, so the controller is a robust controller, without vibrations in case of sudden load variations. In various operating modes constant torque mode, constant speed mode such as engine in running conditions, generation and reverse condition. In all these operating modes, the dynamic response of the BLDC motor observes dynamic parameters of rise time, peak overflow and BLDCM settling time. The engine is quite good with FOSMC compared to the PI controller. The performance of the BLDC motor with the FOSMC methodology provides a smooth and faster torque speed response than the normal PI controller. In [39] Fractional order based super torque algorithm (FOSTA) proposed for controlling the BLDC motor under various operating conditions. Simulations are performed in various operating modes and controller performance is tested on the BLDC dynamic motor model using matlab-simulink. FOSTA performances are compared with the normal PI controller. FOSTA has a good dynamic response compared to the PI controller.

BLDC Motor Mathematical Modelling
State space representation of BLDC motor is represented[40]

$\dot{X}=AX+BX$ (1)

$X=[I_d I_q \ \omega \ \theta]^T$

$\frac{dI_a}{dt}=\frac{V_d}{L}-\frac{I_d}{\tau}+\omega I_q$ (2)

$\frac{dI_q}{dt}=\frac{V_q}{L}-\frac{I_q}{\tau}-\omega I_d-\frac{K_e}{L}\omega$ (3)

$\frac{d\omega}{dt}=\frac{PK_e}{J}I_q-\frac{f}{J}\omega-\frac{P}{J}T_L$ (4)

$\frac{d\theta}{dt}=\omega$

The output   equation is given by

Y=CX, Y=[I_d I_q]^T   (5)

$C=\begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \end{bmatrix}$

V_d, V_q,I_d,I_q are voltages and currents on a (*d*,*q*) frame,

T_L=Load torque, ω- electrical angular velocity,

K_e=factor torque, *L*-inductance, *R*-resistance,

τ = Electric time constant.

$\underline{v}=[\mathbf{R}]\underline{i}+[L]\frac{di}{dt}+\underline{e}$ (6)

Where R is the stator resistance per phase

$$R = \begin{bmatrix} R & 0 & 0 \\ 0 & R & 0 \\ 0 & 0 & R \end{bmatrix}$$

L is the matrix of inductance interims of self and mutual inductance, L_s, M

$$L = \begin{bmatrix} L_s & -M & -M \\ -M & L_s & -M \\ -M & 0 & L_s \end{bmatrix}$$

$\underline{e} = [e_a\, e_b\, e_c]^T$ is the vector of the trapezoidal back EMF

$$\frac{d}{dt}\begin{bmatrix} I_a \\ I_b \\ I_c \end{bmatrix} = \begin{bmatrix} \frac{1}{L_T} & 0 & 0 \\ 0 & \frac{1}{L_T} & 0 \\ 0 & 0 & \frac{1}{L_T} \end{bmatrix}\begin{bmatrix} V_{an} \\ V_{bn} \\ V_{cn} \end{bmatrix} - \begin{bmatrix} R & 0 & 0 \\ 0 & R & 0 \\ 0 & 0 & R \end{bmatrix}\begin{bmatrix} I_a \\ I_b \\ I_c \end{bmatrix} - \begin{bmatrix} e_{an} \\ e_{bn} \\ e_{cn} \end{bmatrix} \qquad (7)$$

$L_T = L_{s+}M$

The equation of motion is

$$J\frac{d\omega_r}{dt} = T_{em} - T_L - f\omega_r \qquad (8)$$

$$T_{em} = \frac{1}{\omega_r}(e_{an}i_a + e_{bn}i_{b} + e_{cn}i_c), \qquad (9)$$

ω_r-mechanical speed [rad/s], T_l– load torque [N m] , J - motor shaft and load inertias [kg m^2]
F –frictional damping coefficient [N m s/rad m],
T_{em} - electromagnetic torque [N].

CONCLUSION

The Performance review of different control strategies for BLDC Motor are conventional controllers(PIC,PIDC), intelligent controllers are (FLC, ANN, FLCANN, HybridFuzzy, NF, VHDL, FPGA, NSGA-II, ZNM, BELBIC) and robust controllers are sliding mode controller as(PIDSMC,FPIDSMC,SMFLC,SMO,ISMO,CSMO) and finally Fractional order controllers are (FOPI, FOFLC, FOSMC, FOSTA) based control scheme is presented in this paper. During the study it was observed that, although fractional order controller displayed improvement in dynamic performance of BLDC motor operating parameters but still it could not establish its superiority indisputably in terms of steady state performance of the system. Various different control scheme were also combined with FOPI controller, FOFL Controller, FOSM Controller and FOSTA to further improve upon its limitation.

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RESEARCH ARTICLE

An Observational Study on Surgical Cases Reporting at the National Institute of Siddha OPD

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ABSTRACT

The Siddha system is an ancient traditional system practiced in southern parts of India. The patient reports at the National Institute of Siddha (NIS) have increased every day. Among them many are surgical cases, reporting NIS for treatment without surgery. The aim of this study is to document the surgical cases reporting towards the Siddha system of medicine at NIS OPD. It is an effort to prove the quality of healthcare in Siddha in such unmanageable cases of the Modern medicine system without surgery. A Hospital-based Cross-sectional observational study was conducted in the year 2018 for three months i.e. June to August on surgical cases reporting at NIS OPD. A total of 200 patients (100 New

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surgical cases and 100 Old surgical cases) were selected through the Judgmental sampling method. The patients of new and old surgical cases were assessed individually well-designed questionnaire. It was approved with the NIS/IEC/2018/22, 07-05-2018, and analyzed using STATA. By analyzing the studySinus and Fistula, Intervertebral disc diseases, Anorectal diseases, and Female Genital tract diseases were the highly reported surgical cases in NIS. Most of the surgical cases didn't opt for Surgery due to recurrence (31%), fear (29%), and hih cost (25%) for treatment. So, prefer the Siddha management without surgical correction. And this study proves 57% of cases were satisfactory with Siddha treatment and 28% of cases were improved after Siddha treatment. The para-surgical procedures such as Karanool, Bone setting, leech therapy, and chemical cauterization were done for those surgical cases in NIS. Surgical cases approaching Siddha medicine give much scope to develop it as a holistic treatment.

Keywords: Surgical cases; Siddha treatment;Para surgical procedures

INTRODUCTION

Siddha system is an ancient traditional system practiced in southern parts of India. Various internal and external medicines mentioned in literature considered as the treasury of Siddha system. In the Siddha system, the treatment has been classified into three groups, such as Vinnavar Maruthuvam, Maanidar Maruthuvam, Asura Maruthuvam. The first two groups refer the method of treatment with oral medications. In the Vinnavar Maruthuvam, medicines like parpam, chenduram, guru, kuligai prepared from mercury, sulphur and pashanams are used. In the Maanidar Maruthuvam, medicines prepared from herbs chunam, ranam, kudineer, vadagam are used. The third groupAsura Maruthuvam refers to method of surgery. They employed the surgical method in various morbid conditions of human body, which could not be cured with oral medications and non-invasive procedures. In Siddha system of medicine, Surgical method (Asura Maruthuvam) it has three divisions: Aruvai, Agni, Karam.

ARUVAI- Diseases treated with surgical instrument
AGNI- Diseases treated with heat application.
KARAM- Diseases treated with chemical cauterization.

Aruvaiis divided into 13 types. It includes Leech application (Attai vidal), Surgical treatment(Aruvai), Incision(Kiral), Bloodletting (Kurthi vangal), Probe application(Salagai vidal), Medicated wick/plug (Varthi), Blowing(Uthal), Enema / Clyster(Piccu), Suction(Urinjal), Bone setting(Kombu kattal), Murical(Therapeutic fracture), Massage(Thokkanam), Banding(kattu). Agni is divided into 5 types. It includes Cauterization (Suttigai), Steam bath (Vedhu), Fomentation (Ottradam), Medicated Pouch (Pottanam), and Fumigation(Pugai). Karam is divided into 7 types. It includes Chemical cauterization (Karam), Mediated Lint (Silai), Ointment(Kalimbu), Medicated powder(Podi), Poultice(Kali), Cream (Pasai).[1]. Most of the above methods are followed in the National Institute of Siddha for various ailments. Ano rectal diseases, bone and ligament injury, disorders of intervertebral discs, and varicose veins are the most reported cases in Aruvai Maruthuvam opd of NIS. The parasurgical procedures such as Karanool, Bone setting, leech therapy, chemical cauterization, and thermal cauterization were performed in those surgical cases in NIS. Siddha system plays a major preventive, curative and promotive role in community health. Most of the conditions which are not treated by other systems of medicine without surgery are managed by internal and external medicines of Siddha or via Para surgical procedures of Siddha system. Considering the increased reporting of surgical cases at NIS for treatment without surgery, a cross sectional study was conducted to explore the quality of healthcare in Siddha in such unmanageable cases of Modern medicine system without surgery and to document the patients reporting in NIS for various surgical conditions. Also to explore the various treatment modalities employed in Siddha System for surgical cases at NIS. Patient satisfaction

Survey about the cases treated in NIS for various surgical conditions were also documented. Surgical cases approaching Siddha medicine give much scope to develop it as a holistic treatment.

MATERIALS AND METHODS

Study design
This Hospital based Cross-sectional study was carried out in the National institute of Siddha, Chennai which is an apex institute for Siddha medicine. The period of study from June to August 2018. Surgery referred cases were selected through the Judgmental sampling method.

Ethical considerations
Before the commencement of the trial, the study protocol was submitted to the institutional ethical committee (IEC number; NIS/IEC/2018/22 Dated: 07-05-2018) of NIS, Chennai and approved. The trial was registered prospectively by the Clinical Trial Registry under clinical trial registration number- CTRI/2018/06/014513. All the participants were explained about the study and provided verbal and written informed consent forms, after getting their signed written informed consent they were enrolled in the study.

Sample size
The patients of New surgical cases and Old surgical cases of the age group between 12 to 65 were assessed individually through well designed questionnaire. 100 New cases and 100 Old cases were selected during their visit to hospital.

Methods of data collection
A total of 200 patients were collected using well designed questionnaire. The patients visiting NIS OPD for various surgical cases were interviewed using a well structural questionnaire. The author conducted the study under the supervision of Head of Department and Faculties of Sirappu Marthuvam in a separate enclosure to ensure the privacy of patients. New cases were selected on the first day of visit to the hospital after consulting respective doctors. They were enquired about their ailment, reason for choosing Siddha, and the management advised by other systems like Allopathy and the type of management advised in National Institute of Siddha. Old cases were selected during their treatment period in siddha. They were enquired about their ailment, the management advised by other system like Allopathy and the type of management they underwent in National Institute of Siddha. Also the prognosis of their ailment after treatment in NIS were analyzed.

STATISTICAL ANALYSIS

All collected data were entered in MS Access software using a pre-designed form for data entry and STATA software was used to perform statistical analysis. Basic descriptive statistics include frequency distributions and tabulations were performed. Statistics were explained through descriptive and cross tabulation.

RESULTS

The results were studied and tabulated under the following heading
1. Source of information about Siddha
2. Source of information about Ayothidass Pandithar Hospital(APH) of National Institute of Siddha(NIS)
3. Age distribution
4. Sex distribution
5. Economic status

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6. Profile of surgical cases reporting NIS OPD
7. Reason for choosing Siddha for surgical cases
8. Cases having recurrence after surgery in Modern Medicine and came for Siddha treatment in NIS
9. Surgical cases reported for Post-surgical management
10. Reason of visit to NIS in new cases
11. Referred surgical cases by NIS
12. Opinion of new cases after first consultation in NIS
13. Mode of treatment in NIS
14. Surgical cases and their Para surgical procedures
15. Prognosis
16. Patient satisfactory survey

Observation

The source of information about siddha for patients visiting APH of NIS were referred by patient treated in NIS (54%) shows the acceptance and satisfaction of patients treated by Siddha Medicine in NIS

Observation

The source of information for patients about NIS were referred by patient treated in NIS (63%) shows the health care service in NIS by Siddha Treatment

Observation

The maximum number of Surgical caseswere in the age group between 40-50 years (29%) and 50-60 years (23%)

Observation

Majority of surgical cases reported were males 59%**.**

Observation

The majority of surgical cases were from Middle class (62.5%) and lower class(31%).

Observation

Sinus and Fistula, Intervertebral disc diseases, Anorectal diseases, Female Genital tract diseases were the highly reported surgical cases in NIS.

Observation

Most of the surgical cases didn't opt for Surgery due to fear of recurrance(31%) and due to fear for surgery(29%) for treatment. So prefer the siddha management without surgical correction.

Observation

Anorectal diseases(26%), Sinus and Fistula(20%) were the mostly reported cases after recurrence in Surgery.

Observation

 Cancer and Anorectal cases were the majority of reported surgical cases for post-surgical management and prevention from recurrence of disease.

Observation

67% of the surgical cases were reported to NIS OPD for treatment without Surgery.

Observation

86% of the surgical cases were opt Siddha for further treatment

Observation

52% of the surgical cases were treated with both internal and external therapies. 31% of the cases were treated with Para surgical procedures along with medications

Observation

Surgical cases who had treatment more than 3 months were analyzed and it shows, in 97% of cases symptoms were reduced and in 93% of cases had no recurrence.

Observation

57% of the surgical cases were satisfactory with Siddha treatment and 28% improved after Siddha treatment.

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DISCUSSION

Surgical procedures have opted for diseases that are not treated with internal medicines alone. Extensive references are seen in ancient Tamil literature with regard to the various methods of treatment with surgical measures. The texts of Siddhars like therar, Agathiyar, Nagamuni explains various surgical procedures. There are 26 types of surgical instruments (Satharavuthangal) mentioned in the text Agathiyar Nayana vidhi. Many surgical methods illustrated in the above literature are not practical in use nowadays. Since few of surgical procedures are used extensively in treating diseases. So this study aimed to document those surgical procedures in various disease conditions. Surgical cases like Anorectal diseases, Varicosities, Ulcers, Sinus and Fistula, Skin and subcutaneous diseases, intervertebral diseases, fractures and ligament injuries, Carcinoma and Neck swelling, Female genital tract diseases, Abdominal cases, Hernia and Renal diseases were the most reported cases in NIS OPD. The mode of treatment in Siddha for such cases were internal medicines, external medicines, and Para surgical procedures. Since Surgery is an expensive procedure with complications and recurrence, many Surgeries referred cases were reported to Siddha for their further management. The recurrence of anorectal cases and frequency of anal fistula is a common surgical case reported at Aruvai Maruthuvam OPD of NIS. The recurrence rate might have been found to be low when patients have taken Siddha medications after surgery. Para surgical procedures such as Leech therapy, Bone setting, Karanool, and Karam (chemical cauterization) are carried out in OPD of the National Institute of Siddha. And this study proves 57% of cases were satisfactory with Siddha treatment and 28% of cases were improved after Siddha treatment.

CONCLUSION

This hospital-based cross-sectional study proves that many surgical cases benefited from Siddha treatment at the National Institute of Siddha. Patients with complaints of Fistula in ano, fracture and ligament injury, and varicosities are the most referred cases those reported in Aruvai Maruthuvam OPD. Parasurgical procedures such as Karanool, Bone setting, leech therapy, and chemical cauterization was done in those surgical cases in NIS. Surgical cases approaching Siddha medicine give much scope to develop it as a holistic treatment.

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CONFLICT OF INTEREST
The authors declare no conflict of interest.

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Table 1: Source of Information About Siddha

Source of information about siddha	New cases (n=100)	Old cases (n=100)	Total (n=200)	Percentage
Self	43	35	78	39%
Referred by doctor	1	3	4	2%
Referred by patient treated in NIS	48	60	108	54%
Media	7	3	10	5%

Table 2: Source of Information about NIS

Source of information about NIS	New cases (n=100)	Old cases (n=100)	Total (n=200)	Percentage
Self	30	32	62	31%
Referred by doctor	1	3	4	2%
Referred by patient treated in NIS	65	63	128	63%
Media	5	3	8	4%

Table 3: Age

Age	New cases (n=100)	Old cases (n=100)	Total (n=200)	Percentage%
12-20	02	02	4	2%
20-30	17	15	32	16%
30-40	21	17	38	19%
40-50	24	34	58	29%
50-60	22	24	46	23%
60-65	13	09	22	11%

Table 4. Sex distribution

Sex	New cases	Old cases	Total	Percentage
MALE	68	54	122	59%
FEMALE	32	46	78	41%

Table 5: Economic Status

Economic status	New cases	Old cases	Total	PERCENTAGE
Lower class	38	24	62	31%
Middle class	54	71	125	62.5%
Upper class	8	5	13	6.5

table 6: Profile of Surgical Cases Reporting in NIS

Diagnosis	New cases (n=100)	Old cases (n=100)	Total (n=200)	Percentage
ULCER	4	12	16	8
SINUS AND	15	11	26	13

FISTULA				
VARICOSITIES	6	8	14	7
FRACTURE	9	3	12	6
LIGAMENT INJURIES	5	3	8	4
DISORDERS OF INTERVERTEBRAL DISC	16	10	26	13
ANORECTAL DISEASES	13	15	28	14
HERNIA	4	0	4	2
ABDOMINAL CASES	2	2	4	2
RENAL CASES	2	4	6	3
NECK AND CHEEK SWELLING	1	5	6	3
SKIN AND SUBCUTANEOUS DISEASES	8	4	12	6
FEMALE GENITAL TRACT DISEASES	6	16	22	11
CARCINOMA	8	7	15	7
CATARACT	2	0	2	1

Table 7: Reason for Patients Choosing Siddha for their Surgical Cases

REASON	NEW CASES	OLD CASES	TOTAL%
Expensive	34	15	24.5%
Fear for surgery	24	35	29.5%
Fear for recurrence	33	29	31%
No one to care them	6	12	9%
Not interested in surgery	3	9	6%

Table 8: Cases Having Recurrence after Surgery in Modern Medicine and Came for Siddha Treatment in NIS

Cases reported for recurrence after surgery	PERCENTAGE%
Anorectal diseases	14
Sinus and Fistula	11
Varicosities	6
Wound	8
Disease of bone and joint	7
Cancer	3
Corn foot	5

Table 9: Surgical Cases Reported For Post-Surgical Management

Cases reported for post-surgical management	Percentage%
ANO rectal diseases	11%
Sinus and Fistula	7%
Varicosities	4%
Wound	2
Cancer	13%
Disease of bone	4%

Table 10: Reason of Visit of Surgical Cases to NIS (Among New Cases)

REASON OF VISIT OF SURGICAL CASES TO NIS	PERCENTAGE%
Treatment without surgery	67%
Obtaining opinion	33%

Table 11: Opinion of Surgical Cases after First Consultation in NIS

PATIENT OPINION AFTER FIRST CONSULTATION IN NIS	PERCENTAGE%
Continue treatment in NIS	86%
Not willing for treatment	14%

Table 12: Mode of Treatment in NIS

Mode of treatment	Percentage %
Internal medicine	13%
External medicine	4%
Both	52%
Para surgical procedures	31%

Table 13: Surgical Cases and Para Surgical Procedures

Surgical cases	Para Surgical cases	Percentage%
Varicose eczema	Leech therapy	5
Wound	Leech therapy	1
Fracture	Bone setting	4
Ligament injury	Bone setting	6
Fistula	Karanool	11
Corn foot	Karam	4

Table 14: Cases Those Symptoms Reduced and Those Had No Recurrence after Siddha Treatment

DIAGNOSIS	SYMPTOMS REDUCED	NO RECURRENCE
WOUND	12	11
SINUS AND FISTULA	11	11
VERICOSE VEIN	8	8
FRACTURE	1	2
LIGAMENT INJURIES	4	4
DISEASES OF BONES	9	10
ANORECTAL DISEASES	14	12

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ABDOMINAL CASES	2	2
RENAL CASES	4	4
NECK AND CHEEK SWELLING	6	6
SKIN AND SUBCTANEOUS DISEASES	4	4
FEMALE GENITAL TRACT DISEASES	16	15
CANCER	6	6
TOTAL	97	93

Table 15: Patient Satisfaction Survey after Getting Treatment More Than 6 Months
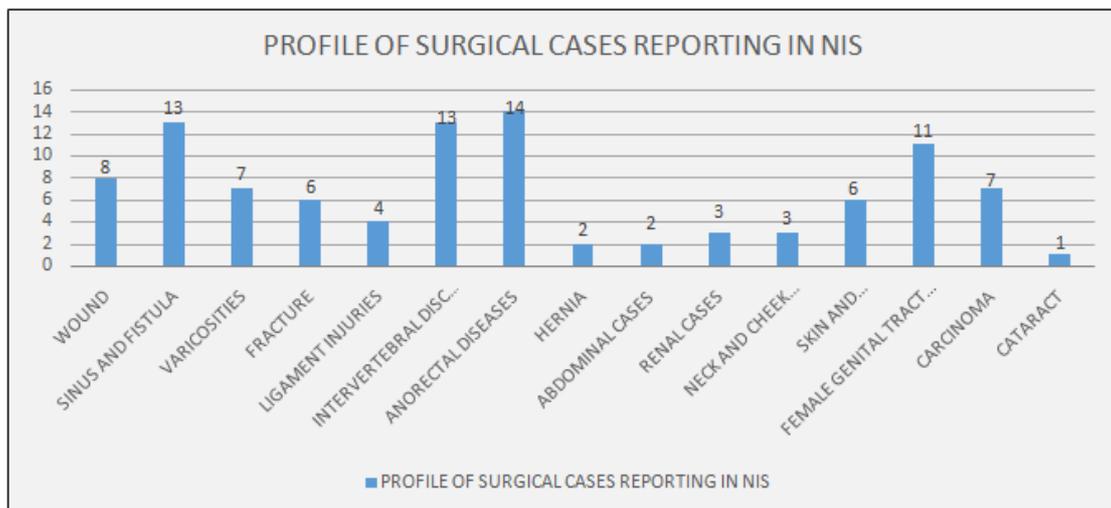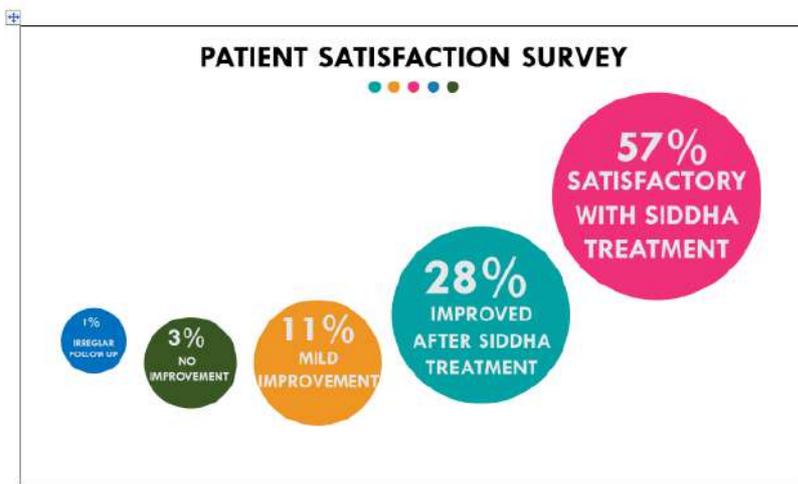
Graph.1. Profile of Surgical Cases Reporting in NIS

RESEARCH ARTICLE

Exploring Gender Role Portrayals in the Novel' Gender Queer : A Memoir Part I

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ABSTRACT

This paper aims to explore the gender role portrayals in the novel "Gender Queer: A Memoir" by Maia Kobabe. The novel is a graphic memoir that delves into the author's personal journey of self-discovery and exploration of gender identity. Through a close analysis of the characters and their interactions, this paper will examine how gender roles are depicted and challenged in the narrative. The paper will begin by providing a brief overview of the novel and its significance in the context of LGBTQ+ literature. It will then delve into the various characters and their representations of gender roles. The protagonist, Maia, will be the primary focus, as their experiences and struggles with gender identity form the core of the narrative. Furthermore, the paper will explore the secondary characters and their impact on the portrayal of gender roles. This includes Maia's family, friends, and romantic partners, all of whom play a role in shaping their understanding of gender. The paper will examine how these characters either reinforce or challenge societal expectations of gender. The paper will also examine the visual elements of the graphic memoir. The illustrations and visual storytelling techniques employed by Kobabe will be analyzed to understand how they contribute to the portrayal of gender roles.

Keywords: Gender identity, Gender roles, Gender stereotypes, LGBTQ+ literature, Coming-of-age

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INTRODUCTION

The introduction of the essay could provide a brief overview of the novel "Gender Queer: A Memoir" and its significance in the context of exploring gender role portrayals. It might touch on the importance of literature in shaping perceptions of gender and identity, and introduce the purpose of the essay, which is to analyze and discuss the portrayal of gender roles in the novel "Gender Queer: A Memoir" The importance of exploring gender role portrayals in the novel "Gender Queer: A Memoir" lies in its potential to foster understanding and dialogue about diverse gender experiences. This analysis can contribute to broader discussions on challenging societal norms, promoting inclusivity, and enhancing empathy towards individuals who navigate complex gender identities. The cultural, social, and historical context surrounding the novel "Gender Queer: A Memoir" is crucial to understanding its portrayal of gender roles. Published on 28 May 2019, during a period of increasing awareness and discussions around gender diversity, the book engages with shifting societal attitudes towards non-binary and transgender identities. Additionally, examining the broader socio-cultural climate during the time of the novel's creation can shed light on how the author's personal experiences and perspectives intersect with larger conversations about gender norms and expectations.

Aims
The aims of this exploration are

1. To dissect the gender role portrayals in "Gender Queer: A Memoir"
2. To analyze how the novel challenges or reinforces conventional notions of gender. By delving into the characters, narratives, and themes
3. This study seeks to reveal the author's intentions, the impact of their choices, and the potential implications for readers' understanding of gender roles and identities.
4. Ultimately, the goal is to contribute to a nuanced dialogue surrounding gender diversity and representation in literature.

OBJECTIVES
The objectives of this exploration include

1. **Character Analysis :** To analyze the development of characters in "Gender Queer: A Memoir" and examine how their gender roles and identities are portrayed throughout the narrative.

2. **Theme Examination :** To identify and discuss recurring themes related to gender roles, expectations, and challenges that emerge in the novel.

3. **Author's Intent :** To interpret the author's intentions behind their portrayal of gender roles and investigate how they contribute to the overarching message of the novel.

4. **Impact on Readers :** To explore how the novel's portrayal of gender roles might influence readers' perspectives on gender diversity, identity, and societal norms.

5. **Critical Analysis :** To critically assess whether the novel challenges or reinforces prevailing notions of gender, considering both the author's intentions and potential reader interpretations.

6. **Contribution to Discourse :** To contribute to ongoing conversations about gender representation in literature and provide insights into the evolving understanding of gender roles in contemporary society.

METHODOLOGY

The study will employ a qualitative analysis approach, this exploration involves a comprehensive reading, interpreting and exhaustive analysis of primary source "Gender Queer: A Memoir" through qualitative research methods. The study navigates through assessment of psychological, gender, ethical and social issues. The existing

critical material, discourse analysis. Aims identify and examine instances where gender roles and stereotypes are presented, challenged, or subverted.

Areas of exploration
Chapter 1
Identification of traditional gender roles and stereotypes presented in the novel.
"Gender Queer: A Memoir" is an autobiographical graphic novel by Maia Kobabe, which explores their experiences with gender and sexuality. In the book, traditional gender roles and stereotypes are challenged and deconstructed in various ways:

Binary Gender Norms
Maia questions the traditional binary understanding of gender as male and female, highlighting the limitations and constraints it imposes on individuals who don't fit neatly into these categories. The novel challenges binary gender norms by chronicling the author's personal journey of self-discovery and their experiences navigating a non-binary identity. It delves into the complexities of gender and relationships, shedding light on the fluidity and diversity of gender expressions and orientations. The book serves as a powerful narrative that challenges traditional binary gender norms and invites readers to reconsider their understanding of gender.

Gendered Clothing
The author discusses the topic of gendered clothing and its significance in their personal journey. Throughout the novel, Maia explores their discomfort with traditional gendered clothing expectations and the challenges they face in finding clothing that aligns with their gender identity, which is non-binary. This exploration highlights how society's rigid gender norms and clothing expectations can be limiting and restrictive for individuals who don't fit within the binary. Maia's experiences with clothing serve as a central theme in the book, illustrating the ways in which clothing can be a powerful tool for self-expression and identity exploration. It also underscores the importance of breaking free from societal expectations and embracing one's true self, even when it comes to something as seemingly simple as clothing choices. The novel provides valuable insights into the complexities of gender and clothing and how these aspects are intertwined in the author's journey of self-discovery.

Sexual Orientation Stereotypes
Maia's experiences as asexual and questioning of societal expectations are a central theme. Maia Kobabe, who identifies as a non-binary and asexual person. The novel is a coming-of-age story that explores themes of gender identity and sexuality. In the book, Maia challenges many stereotypes and misconceptions related to sexual orientation and gender. They share personal experiences and feelings about their own journey, shedding light on the complexities of human identity beyond traditional stereotypes. The book aims to break down these stereotypes and promote a more inclusive understanding of sexual orientation and gender diversity.

Body Image and Expectations
Maia's journey as a non-binary person involves navigating their own feelings and societal pressures regarding their physical appearance. They candidly explore their experiences with body dysphoria, the discomfort or distress related to the incongruence between one's gender identity and physical body. Throughout the novel, Maia shares personal stories and illustrations that highlight the struggles and complexities of coming to terms with their own body image. They challenge traditional norms and expectations surrounding physical appearance and emphasize the importance of self-acceptance and self-love. In doing so, the book contributes to the ongoing conversation about body image, encouraging readers to reconsider and question societal ideals and standards, particularly as they relate to gender identity and expression. It promotes a more inclusive and empathetic understanding of diverse body types and appearances.

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Gendered Language and Pronoun

Maia Kobabe, the author explores the use of gendered language and pronouns in a deeply personal way. Maia, who identifies as non-binary and asexual, reflects on their own experiences with pronouns and how language can impact one's sense of self and identity. Throughout the book, Maia discusses their preference for gender-neutral pronouns such as "they/them" and their encounters with others who may not understand or respect their chosen pronouns. This exploration sheds light on the challenges and misunderstandings that non-binary individuals often face in a world where gendered language is the norm. The novel serves as a valuable resource for readers to understand the significance of using correct pronouns and inclusive language when interacting with people of diverse gender identities. It encourages empathy and respect for individuals who, like Maia, navigate a world that often imposes rigid gender expectations and language constructs.

Family and Social Pressure

Maia Kobabe, the author candidly discusses the impact of family and social pressures on their journey of self-discovery and understanding of their gender identity and sexuality. Maia shares their experiences of coming out to their family and the mixed reactions they received. The novel portrays the challenges Maia faced in reconciling their own identity with the expectations and norms imposed by their family and society. It highlights the tension between the desire for acceptance and the need to be true to oneself. Throughout the book, Maia's narrative sheds light on the broader societal pressures and stereotypes related to gender and sexuality, showing how these can affect an individual's self-esteem and mental well-being. Ultimately, "Gender Queer: A Memoir" provides readers with a deeply personal and relatable perspective on the complexities of family and social dynamics when it comes to accepting and understanding gender and sexual diversity. It emphasizes the importance of empathy, communication, and support in navigating these challenges.

Sex Education and Stereotype

The author explores themes related to sex education and stereotypes. Maia's journey as a non-binary and asexual individual involves navigating their own understanding of sexuality and relationships in a society where conventional norms and stereotypes often prevail. The book touches on Maia's experiences with sex education and the lack of representation and information about non-binary identities and asexuality. Maia challenges stereotypes surrounding asexuality and portrays their own experiences in a way that educates readers about this often misunderstood sexual orientation. By sharing their personal experiences and feelings, Maia aims to break down stereotypes and misconceptions related to both non-binary identities and asexuality. The book encourages readers to question traditional views on sexuality and relationships, promoting a more inclusive and informed understanding of diverse sexual orientations and gender identities.

CONCLUSION

The novel "Gender Queer: A Memoir" by Maia Kobabe serves as a powerful exploration of gender role portrayals that challenges and subverts traditional norms. Through the author's personal perspective on gender identity and expression, the book offers readers a unique glimpse into the world of non-binary and genderqueer experiences, ultimately contributing to broader discussions on gender diversity and inclusivity. Kobabe's fluid and non-binary identity, rejection of gender stereotypes, and open discussions on sexuality and relationships challenge societal expectations surrounding gender roles. The memoir also delves into the complexities of family and societal acceptance, shedding light on the hurdles faced by individuals whose gender identities do not conform to traditional norms. "Gender Queer: A Memoir" encourages self-exploration, empathy, and understanding, making it a valuable resource for readers, educators, and advocates interested in promoting a more inclusive and tolerant society. Through its candid and relatable storytelling, this book normalizes conversations about gender diversity and advocates for a world where all gender identities are accepted and celebrated. n essence, the novel serves as both a personal narrative and a platform for broader social change, challenging the status quo and inspiring discussions

that contribute to a more inclusive and empathetic world. Maia Kobabe's memoir exemplifies the power of literature in fostering understanding and acceptance of diverse gender experiences.

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Conflict of Interest

The author declares no conflict of interest.

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RESEARCH ARTICLE

A New Approach for Solving ZLPP

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ABSTRACT

In management, economics, operation research, and many other industrial applications, a linear programming model is crucial. In situations where the data is uncertain and not hundred percent reliable, it is good to use linear programming modelled with Z-number parameters (ZLPM). We show how to convert Z-linear programming problem to a fuzzy linear programming problem with a certain reliability. Then the FLP problem can be tackled by using suitable existing methods. This approach ensures that the information regarding reliability is not lost.

Keywords: Fuzzy sets, Z-number, Ranking function, Triangular Z-number, Fuzzy linear Programming problem, Z-linear programming problem.

INTRODUCTION

Many application problems, modelled as mathematical programming problems may be formulated with uncertainty. Tanaka *et al*. [1]originally put out the idea of fuzzy mathematical programming at the general level within the context of Bellman and Zadeh's fuzzy decision [2]. Zimmermann [3] put forward the first fuzzy linear programming (FLP) concept. Afterward, many authors considered various types of FLP problems and proposed several approaches for solving them[4-6]. A novel method for resolving FLP problems based on Z-number was presented by T.Allahviranloo.et.al [7].Kumar *et al*. [8] proposed a new method to find the fuzzy optimal solution of fully fuzzy linear programming problems. Ganesan and Veeramani [9] introduced a new approach for solving a kind of linear programming involving symmetry trapezoidal fuzzy numbers without converting them to crisp linear programming problems. A note on FLP problems utilizing L-R fuzzy numbers was published by Nagoor Gani *et al* in [10]. Recently,

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Zadeh introduced the notation of Z-numbers in 2011. The idea of a Z-number has to do with the dependability of information. In this paper, we converted the ZLP problem into an FLP problem, and the FLP problem has already existing methods and the proposed method utilizes R-type operations introduced by Stephen [11].

Preliminaries

Definition: Fuzzy set

A fuzzy set in X is defined as a set of ordered pairs A=$\{(x, \mu_A(x)) | x \in X\}$, where $\mu_A(x)$ is referred to as the membership function for the fuzzy set. If X is a group of objects represented by the generic symbol X, then X is the definition of a fuzzy set A in X. Each element of X is assigned a membership value between 0 and 1 using the membership function.

Definition: Triangular fuzzy number

A fuzzy number $\tilde{A}$= (a,b, c) is defined as a triangular fuzzy number only if the membership function of this is represented as:

$$\mu_{\tilde{A}}(x) = \begin{cases} \frac{x-a}{b-a} & a \leq x \leq b \\ \frac{c-x}{c-b} & b \leq x \leq c \\ 0 & c \leq x \leq d \end{cases}$$

Definition: Ranking function

Let F(R) be a set of fuzzy numbers that is defined as a set of real numbers. Function $\Re: F(R) \to R$, is a ranking function that maps every fuzzy number into the real line.

Definition: Zadeh's definition of z-number

AZ-number is an ordered pair of fuzzy numbers Z=(A,B), associated with the uncertain real-valued variable X, with the first component A, a restriction on the possible values for X, as well as the second component B, a measure of the first component's reliability.

Definition: Triangular Z-number

In the Z-number Z= (A, B), if both components A and B are triangular fuzzy numbers, then the corresponding Z-number is called a Triangular Z-number.

Definition: MIN R Type operation

Let $* \epsilon \{+, -, \times, /\}$, the MIN R operation on the set of all continuous Z-number is defined to be
(A, B)($*$, min)(C, D)= (A$*$C, min (B, D)), where the extension principle is used to calculate A$*$C and min (B, D) = B if $R_k(B) < R_k(D)$ and D if $R_k(D) < R_k(B)$

Definition: Sum of two Triangular Z-numbers by MIN R

Let Z_1= (A_1, B_1) & Z_2= (A_2, B_2) be any two Triangular Z-numbers, then $Z_1(+, min)Z_2 = (A_1, B_1)(+, min)(A_2, B_2) = (A_1 + A_2, min(B_1, B_2))$

Definition: Product R Type operation

Let $* \epsilon \{+, -, \times, /\}$, the Product R operation on the set of all continuous Z-number is defined to be
(A, B)($*, \cdot$)(C, D)= (A$*$C, B $\cdot$ D), where A$*$C and B $\cdot$ D are calculated using extension principle

Definition: Sum of two Triangular Z-numbers by Product R

Let Z_1= (A_1, B_1) & Z_2= (A_2, B_2) be any two Triangular Z-numbers, then $Z_1(+, \cdot)Z_2 = (A_1, B_1)(+, \cdot)(A_2, B_2) = (A_1 + A_2, B_1 \cdot B_2)$

Converting ZLPP to FUZZY LPP

The ZLPP is mathematically formulated as mentioned below:

Max $\sum_{j=1}^{n} c_j x_j$

Subject to

$$\sum_{j=1}^{n} a_{ij} x_j \leq b_i \quad \forall\, i = 1,2,3, \ldots, m$$

$x_j \geq 0 \ \forall\, j = 1,2,3, \ldots, n$

where $c_j = (c_{j1}, c_{j2})$, $a_{ij} = (a_{ij1}, a_{ij2})$ and $b_i = (b_{i1}, b_{i2})$ are all Z-numbers.

In this section, novel approach to solving the Z-linear programming problem is suggested.

Let us discuss two distinct cases related to the Z-linear programming problem

Case (i):

Here the summation is interpreted as a (+, min) operation.

Consider the ZLPP

Max $\left[(c_1, c_1') x_1 (+, \min)(c_2, c_2') x_2 (+, \min) \ldots (+, \min)(c_n, c_n') x_n \right]$

Subject to

$(a_{11}, a_{11}') x_1 (+, \min)(a_{12}, a_{12}') x_2 (+, \min) \ldots (+, \min)(a_{1n}, a_{1n}') x_n \leq (b_1, b_1')$

$(a_{21}, a_{21}') x_1 (+, \min)(a_{22}, a_{22}') x_2 (+, \min) \ldots (+, \min)(a_{2n}, a_{2n}') x_n \leq (b_2, b_2')$

$(a_{31}, a_{31}') x_1 (+, \min)(a_{32}, a_{32}') x_2 (+, \min) \ldots (+, \min)(a_{3n}, a_{3n}') x_n \leq (b_3, b_3')$

$$\vdots \cdots \vdots$$

$(a_{m1}, a_{m1}') x_1 (+, \min)(a_{m2}, a_{m2}') x_2 (+, \min) \ldots (+, \min)(a_{mn}, a_{mn}') x_n \leq (b_m, b_m')$

$$x_1, x_2, x_3, \ldots, x_n \geq 0$$

The above ZLPP is converted into the following FLPP

Max $[c_1 x_1 + c_2 x_2 + c_3 x_3 + \cdots + c_n x_n]$

Subject to

$a_{11} x_1 + a_{12} x_2 + a_{13} x_3 + \cdots + a_{1n} x_n \leq b_1$

$a_{21} x_1 + a_{22} x_2 + a_{23} x_3 + \cdots + a_{2n} x_n \leq b_2$

$a_{31} x_1 + a_{32} x_2 + a_{33} x_3 + \cdots + a_{3n} x_n \leq b_3$

$\vdots\vdots\vdots\vdots\vdots$

$a_{m1} x_1 + a_{m2} x_2 + a_{m3} x_3 + \cdots + a_{mn} x_n \leq b_m$

$x_1, x_2, x_3, \ldots, x_n \geq 0$

The reliability of this system is

Min $(c_1', c_2', \ldots, c_n', a_{11}', a_{12}', \ldots, a_{n1}', a_{21}', a_{22}', \ldots, a_{2n}', \ldots, a_{m1}', a_{m2}', \ldots, a_{mn}', b_1', b_2', \ldots, b_m')$

Solving the FLPP:

Consider the case where $c_1, c_2, \ldots, c_n,\ a_{11}, a_{12}, \ldots, a_{n1},\ a_{21}, a_{22}, \ldots, a_{2n},\ \ldots, a_{m1}, a_{m2}, \ldots, a_{mn},\ b_1, b_2, \ldots, b_m$ are all triangular fuzzy numbers.

Suppose $c_j = (c_{j1}, c_{j2}, c_{j3})$, $a_{ij} = (a_{ij1}, a_{ij2}, a_{ij3})$ and $b_i = (b_{i1}, b_{i2}, b_{i3})$

Then the FLPP can be converted to LPP by the method suggested by Klir and Yuan[12]

Choose a suitable ranking function R. Let $C_j = R(c_j)$. Then the objective function is converted to $C_1 x_1 + C_2 x_2 + \cdots + C_n x_n$

$a_{111} x_1 + a_{121} x_2 + \cdots + a_{1n1} x_n \leq b_{11}$

$a_{112} x_1 + a_{122} x_2 + \cdots + a_{1n2} x_n \leq b_{12}$

$a_{113} x_1 + a_{123} x_2 + \cdots + a_{1n3} x_n \leq b_{13}$

$a_{211} x_1 + a_{221} x_2 + \cdots + a_{2n1} x_n \leq b_{21}$

$a_{212} x_1 + a_{222} x_2 + \cdots + a_{2n2} x_n \leq b_{22}$

$a_{213} x_1 + a_{223} x_2 + \cdots + a_{2n3} x_n \leq b_{23}$

$\vdots \cdots \vdots$

$a_{m11} x_1 + a_{m21} x_n + \cdots + a_{mn1} x_n \leq b_{m1}$

$a_{m12} x_1 + a_{m22} x_n + \cdots + a_{mn2} x_n \leq b_{m2}$

$a_{m13} x_1 + a_{m23} x_n + \cdots + a_{mn3} x_n \leq b_{m3}$

and $x_1, x_2, x_3, \ldots, x_n \geq 0$

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Example 1:

Consider the ZLPP

Max $(c_1, c_1')x_1(+,\min)(c_2, c_2')x_2(+,\min)(c_3, c_3')x_3$

Subject to constraints

$(a_{11}, a_{11}')x_1(+,\min)(a_{12}, a_{12}')x_2(+,\min)(a_{13}, a_{13}')x_3 \le (b_1, b_1')$

$(a_{21}, a_{21}')x_1(+,\min)(a_{22}, a_{22}')x_2(+,\min)(a_{23}, a_{23}')x_3 \le (b_2, b_2')$

$x_j \ge 0$

Where the c_j, a_{ij} and b_i are given in the following table

c_1	c_2	c_3
(around 14, very sure)	(around 13, sure)	(around 16, almost sure)

a_{ij}			b_i
a_{i1}	a_{i2}	a_{i3}	
(approximately 12, very sure)	(approximately 13, sure)	(approximately 12, sure)	(approximately 500, sure)
(approximately 14, sure)	(0,1)	(approximately 13, very sure)	(approximately 470, sure)

The linguistic terms can be converted to fuzzy terms in the following table:

c_1	c_2	c_3
((12,14,16), (.85,.9,.95))	((11,13,15),(.75,.8,.85))	((15,16,17),(.65,.7,.75))

a_{ij}			b_i
a_{i1}	a_{i2}	a_{i3}	
((10,12,14), (.85,.9,.95))	((11,13,15), (.75,.8,.85))	((10,12,14), (.75,.8,.85))	((480,490,500), (.75,.8,.85))
((12,14,16), (.75,.8,.85))	((0,0,0),(1,1,1))	((11,13,15), (.85,.9,.95))	((460,470,480), (.75,.8,.85))

Solution

First, we convert the given ZLPP into FLPP

Max $(12,14,16)x_1 + (11,13,15) x_2 + (15,16,17) x_3$

Subject to constraints

$(10,12,14) x_1 + (11,13,15) x_2 + (10,12,14) x_3 \le (480,490,500)$

$(12,14,16) x_1 + (11,13,15) x_3 \le (460,470,480)$

$x_1, x_2, x_3 \ge 0$

The reliability of this FLPP system isMin (very sure, sure, completely sure, almost sure)

= Min ((.85,.9,.95),(.75,.8,.85),(1,1,1),(.65,.7,.75))

=(.65, .7, .75) = almost sure

We can rewrite it as the following LPP using the method of Klir and Yuan[12]

Max $14x_1+13x_2+16x_3$

Subject to constraints

$10x_1+11x_2+10x_3 \le 480$

$12x_1 + 13x_2 + 12x_3 \le 490$

$14x_1+15x_2+14x_3 \le 500$

$12x_1+11x_3 \le 460$

$14x_1 + 13x_3 \le 470$

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$16x_1+15x_3 \leq 480$

$x_1, x_2, x_3 \geq 0$

The initial simplex table is represented as

c_B	Basis	c_j x_B	14 x_1	13 x_2	16 x_3	0 s_1	0 s_2	0 s_3	0 s_4	0 s_5	0 s_6
0	s_1	480	10	11	10	1	0	0	0	0	0
0	s_2	490	12	13	12	0	1	0	0	0	0
0	s_3	500	14	15	14	0	0	1	0	0	0
0	s_4	460	12	0	11	0	0	0	1	0	0
0	s_5	470	14	0	13	0	0	0	0	1	0
0	s_6	480	16	0	15	0	0	0	0	0	1

The solution to the above simplex method is given by

c_B	Basis	c_j x_B	14 x_1	13 x_2	16 x_3	0 s_1	0 s_2	0 s_3	0 s_4	0 s_5	0 s_6
0	s_1	$\frac{1828}{15}$	$\frac{4}{225}$	0	0	1	0	$\frac{-11}{15}$	0	0	$\frac{4}{225}$
0	s_2	$\frac{914}{15}$	$\frac{2}{225}$	0	0	0	1	$\frac{-13}{15}$	0	0	$\frac{2}{225}$
13	x_2	$\frac{52}{15}$	$\frac{-14}{225}$	1	0	0	0	$\frac{1}{15}$	1	0	$\frac{-14}{225}$
0	s_4	108	$\frac{4}{15}$	0	0	0	0	0	1	0	$\frac{-11}{15}$
0	s_5	54	$\frac{2}{15}$	0	0	0	0	0	0	1	$\frac{-13}{15}$
16	x_3	32	$\frac{16}{15}$	0	1	0	0	0	0	0	$\frac{1}{15}$
	z_j	$\frac{8356}{15}$	$\frac{3658}{15}$	13	16	0	0	$\frac{13}{15}$	0	0	$\frac{58}{225}$
	$z_j - c_j$	$\frac{508}{225}$	0	0	0	0	$\frac{13}{15}$	0	0	$\frac{58}{225}$

As all$z_j - c_j \geq 0$,the current basic feasible solution is optimal and the solution for the LPP is as follows:

$x_1 = 0$,$x_2 = \frac{52}{15}$, $x_3 = 32$and Max$\frac{8356}{15}$

The solution for the FLPP is $x_1 = 0$,$x_2 = \frac{52}{15}$, $x_3 = 32$and

Max $(12,14,16)0+ (11,13,15)\frac{52}{15}$ +(15,16,17) 32

$= (0,0,0) + \left(\frac{572}{15}, \frac{676}{15}, 52\right) + (480, 512,544)$

$= \left(\frac{7772}{15}, \frac{8356}{15}, 596\right)$

The solution to the ZLPP is $x_1 = 0$, $x_2 = \frac{52}{15}$, $x_3 = 32$and Max$=\left(\left(\frac{7772}{15}, \frac{8356}{15}, 596\right), (.65,.7,.75)\right)$

Case (ii):

Here the summation is interpreted as a $(+,\cdot)$ operation.

Consider the ZLPP

Max $\left[(c_1, c_1')x_1(+,\cdot)(c_2, c_2')x_2(+,\cdot) \ldots (+,\cdot)(c_n, c_n')x_n\right]$

Subject to

$(a_{11}, a_{11}')x_1(+,\cdot)(a_{12}, a_{12}')x_2(+,\cdot) \ldots (+,\cdot)(a_{1n}, a_{1n}')x_n \leq (b_1, b_1')$

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$(a_{21}, a_{21}')x_1(+,\cdot)(a_{22}, a_{22}')x_2(+,\cdot) \dots (+,\cdot)(a_{2n}, a_{2n}')x_n \le (b_2, b_2')$

$(a_{31}, a_{31}')x_1(+,\cdot)(a_{32}, a_{32}')x_2(+,\cdot) \dots (+,\cdot)(a_{3n}, a_{3n}')x_n \le (b_3, b_3')$

$\vdots \vdots \dots \vdots \vdots$

$(a_{m1}, a_{m1}')x_1(+,\cdot)(a_{m2}, a_{m2}')x_2(+,\cdot) \dots (+,\cdot)(a_{mn}, a_{mn}')x_n \le (b_m, b_m')$

$x_1, x_2, x_3, \dots, x_n \ge 0$

The above ZLPP is converted into the following FLPP

Max $[c_1x_1 + c_2x_2 + c_3x_3 + \dots + c_nx_n]$

Subject to

$a_{11}x_1 + a_{12}x_2 + a_{13}x_3 + \dots + a_{1n}x_n \le b_1$

$a_{21}x_1 + a_{22}x_2 + a_{23}x_3 + \dots + a_{2n}x_n \le b_2$

$a_{31}x_1 + a_{32}x_2 + a_{33}x_3 + \dots + a_{3n}x_n \le b_3$

$\vdots\vdots\vdots\vdots\vdots$

$a_{m1}x_1 + a_{m2}x_2 + a_{m3}x_3 + \dots + a_{mn}x_n \le b_m$

$x_1, x_2, x_3, \dots, x_n \ge 0$

The reliability of this system is

Product $(c_1', c_2', \dots, c_n', a_{11}', a_{12}', \dots, a_{n1}', a_{21}', a_{22}', \dots, a_{2n}', \dots, a_{m1}', a_{m2}', \dots, a_{mn}', b_1', b_2', \dots, b_m')$

Solving the FLPP

Consider the case where $c_{11}, c_{21}, \dots, c_{n1}$, $a_{11}, a_{12}, \dots, a_{n1}$, $a_{21}, a_{22}, \dots, a_{2n}$, $\dots, a_{m1}, a_{m2}, \dots, a_{mn}$, $b_{11}, b_{21}, \dots, b_{m1}$ are all triangular fuzzy numbers.

Suppose $c_j = (c_{j1}, c_{j2}, c_{j3})$, $a_{ij} = (a_{ij1}, a_{ij2}, a_{ij3})$ and $b_i = (b_{i1}, b_{i2}, b_{i3})$

Choose a suitable ranking function R. Let C_j=R (c_j). Then the objective function is converted to $C_1x_1 + C_2x_2 + \dots + C_nx_n$

Then the FLPP can be converted to LPP by the method suggested by Klir and Yuan[12]

$a_{111}x_1 + a_{121}x_2 + \dots + a_{1n1}x_n \le b_{11}$

$a_{112}x_1 + a_{122}x_2 + \dots + a_{1n2}x_n \le b_{12}$

$a_{113}x_1 + a_{123}x_2 + \dots + a_{1n3}x_n \le b_{13}$

$a_{211}x_1 + a_{221}x_2 + \dots + a_{2n1}x_n \le b_{21}$

$a_{212}x_1 + a_{222}x_2 + \dots + a_{2n2}x_n \le b_{22}$

$a_{213}x_1 + a_{223}x_2 + \dots + a_{2n3}x_n \le b_{23}$

$\vdots \vdots \dots \vdots \vdots$

$a_{m11}x_1 + a_{m21}x_n + \dots + a_{mn1} \le b_{m1}$

$a_{m12}x_1 + a_{m22}x_n + \dots + a_{mn2} \le b_{m2}$

$a_{m13}x_1 + a_{m23}x_n + \dots + a_{mn3} \le b_{m3}$

$x_1, x_2, x_3, \dots, x_n \ge 0$

Example 2

Consider the ZLPP

Max $(c_1, c_1')x_1(+,\cdot)(c_2, c_2')x_2$

Sub to constraints

$(a_{11}, a_{11}')x_1(+,\cdot)(a_{12}, a_{12}')x_2 \le (b_1, b_1')$

$(a_{21}, a_{21}')x_1(+,\cdot)(a_{22}, a_{22}')x_2 \le (b_2, b_2')$

$x_j \ge 0$

c_1	c_2
(around 6 , very sure)	(around 8, completely sure)

Where the c_j, a_{ij} and b_i are given in the following table

a_{ij}		b_i
a_{i1}	a_{i2}	
(approximately 30, very sure)	(approximately 20, completely sure)	(approximately 300, sure)
(approximately 5, completely sure)	(approximately 10, sure)	(approximately 110, very sure)

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The linguistic terms can be converted to fuzzy terms in the following table:

c_1	c_2
((5,6,7), (.85,.9,.95))	((7,8,9), (1,1,1))

a_{ij}		b_i
a_{i1}	a_{i2}	
((28,30,32), (.85,.9,.95))	((18,20,22), (1,1,1))	((280,300,320) (.75,.8,.85))
((4,5,6), (1,1,1))	((8,10,12), (.75,.8,.85))	((90,110,130), (.85,.9,.95))

Solution

First we convert the given ZLPP into FLPP

Max $(5,6,7)x_1 + (7,8,9)x_2$

Subject to constraints

$(28,30,32) x_1 + (18,20,22) x_2 \leq (280,300,320)$

$(4,5,6) x_1 + (8,10,12) x_2 \leq (90,110,130)$

$x_1, x_2 \geq 0$

The reliability of this FLPP system is =product (very sure, completely sure, sure)

$=(.85,.9,.95) \cdot (1,1,1) \cdot (.75,.8,.85)$

$= (0.6375, 0.72, 0.8075)$

We can rewrite it as the following LPP using the method of Klir and Yuan[12]

Max $6x_1 + 8x_2$

Subject to constraints

$28x_1 + 18x_2 \leq 280$
$30x_1 + 20x_2 \leq 300$
$32x_1 + 22x_2 \leq 320$
$4x_1 + 8x_2 \leq 90$
$5x_1 + 10x_2 \leq 110$
$6x_1 + 12x_2 \leq 130$
$x_1, x_2 \geq 0$

The initial simplex table is represented by

c_B	Basis	c_B x_B	6 x_1	8 x_2	0 s_1	0 s_2	0 s_3	0 s_4	0 s_5	0 s_6
0	s_1	280	28	18	1	0	0	0	0	0
0	s_2	300	30	20	0	1	0	0	0	0
0	s_3	320	32	22	0	0	1	0	0	0
0	s_4	90	4	8	0	0	0	1	0	0
0	s_5	110	5	10	0	0	0	0	1	0
0	s_6	130	6	12	0	0	0	0	0	1

The solution to the above simplex method is given by

c_B	Basis	c_B x_B	6 x_1	8 x_2	0 s_1	0 s_2	0 s_3	0 s_4	0 s_5	0 s_6
0	s_1	$\dfrac{700}{63}$	0	0	1	0	$-\dfrac{19}{21}$	0	0	$\dfrac{20}{126}$
0	s_2	$\dfrac{350}{63}$	0	0	0	1	$-\dfrac{20}{21}$	0	0	$\dfrac{10}{126}$
6	x_1	$\dfrac{245}{63}$	1	0	0	0	$\dfrac{1}{21}$	0	0	$-\dfrac{11}{126}$

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0	s_4	$\frac{10}{3}$	0	0	0	0	0	0	1	$-\frac{2}{3}$
0	s_5	$\frac{5}{3}$	0	0	0	0	0	0	1	$-\frac{5}{6}$
8	x_2	$\frac{80}{9}$	0	1	0	0	$-\frac{1}{42}$	0	0	$\frac{8}{63}$
	z_j	$\frac{850}{9}$	6	8	0	0	$\frac{2}{21}$	0	0	$\frac{31}{63}$
		$z_j - c_j$	0	0	0	0	$\frac{2}{21}$	0	0	$\frac{31}{63}$

As all $z_j - c_j \geq 0$, the current basic feasible solution is optimal and the solution for the LPP is as follows:$x_1 = \frac{245}{63}$, $x_2 = \frac{80}{9}$ and Max = $\frac{850}{9}$

The solution for the FLPP is $x_1 = \frac{245}{63}$, $x_2 = \frac{80}{9}$ and

Max $(5,6,7)\frac{245}{63} + (7,8,9)\frac{80}{9} = \left(\frac{175}{9}, \frac{210}{9}, \frac{245}{9}\right) + \left(\frac{560}{9}, \frac{640}{9}, 80\right)$

$$= \left(\frac{735}{9}, \frac{850}{9}, \frac{965}{9}\right)$$

The solution to the ZLPP is $x_1 = \frac{245}{63}$, $x_2 = \frac{80}{9}$ and Max = $\left(\left(\frac{735}{9}, \frac{850}{9}, \frac{965}{9}\right), (0.6375, 0.72, 0.8075)\right)$

CONCLUSION

An innovative approach to solving ZLPP has been provided in this paper. Here we have demonstrated the approach using numerical examples.

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RESEARCH ARTICLE

Environmental Studies' Emerging Roots and New Constellations on Nature : A Critical Analysis

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ABSTRACT

The study of texts, images, and films that create and reflect human interactions with the natural environment and with nonhuman species is an integral part of the Environmental humanities s. It is usually told as a development from an original focus on mostly British and American literatures of the last two hundred years to a much broader comparatist spectrum of literatures and periods. The convergence of colonial oppression and environmental degradation, the unequal distribution of resources and risks, and the continuing conditions of social justice are highlighted. Thus ecocriticism exemplifies the diffusion of comparatist assumptions and perspectives into other fields of literary study, as comparative and seeks to connect environmentally oriented research across a variety of disciplines in the humanities and social sciences. In order to do so, this research paper addresses environmental views which have been lacking from disciplines such as history, literature and philosophy.

Keywords: Environmental degradation, social justice, environmental humanities, comparative assumtions

INTRODUCTION

Nature nurtures human life in its own way. It's not opaque, it's dynamic, it's capricious, and it's arbitrary. It is intended to strengthen humanity all over the world. It'll cover the whole planet and form a functional ecosystem. It provides for the maintenance of individual species in harmony. The most remarkable thing is that plants and microbes allow oxygen and water to live. A feeling of wonder and worry is always born out of love and fascination with nature. The rapid growth of interdisciplinary discussions has been fueled by the writings of humanized writers on environment issues. Many stories and tales created discourses on the charismatic earth and its sacredness while

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science finds it as an ecological function of the ecosystem. Many stories and legends have been written about a charismatic planet with its sacredness, while scientists think it is an essential function of the ecosystem. In their practices of producing meaning, the environment and humanities are always looking for reform. The first environmental thinker and literary artist, Henry David Thoreau, lived deliberately in the woods, and his experiments at the edge of the pond were partly economic. Thoreau is not opposed to labor; rather, he believes that people sacrifice the vital elements of their lives like self actualization, communities, places and posterity in a bid to sell themselves as labourers. He encouraged people to drive life into a corner and find in it deep meaning, spiritual fulfilment, aesthetic pleasure, ecological literacy and community vitality. His two-year experiment at the pond's edge was an effort to document different ways to understand and value living a simple life to nature. Thus, many writers have interlinked nature and have always permeated literature emphasising nature in their writing. By writing about them and teaching them to keep them in print, ecologists have already been actively engaged in the recovery and promotion of neglected works.

Over a decade the New York Times declared the "Greening of the Humanities" (DeLoughary), a remarkable shift that highlights the role of literature in mediating environmental knowledge and in articulating a poetics of place in the alienating wake of globalization. This change has renewed the humanities and provided a methodology to consider an environment's complex history in order to think about new directions for our ecologies. Despite the digitization, an approach inspired by theory and practice is needed in order to cope with environmental chaos. The demand for solutions to the global ecological crisis thus has a new kind of thinking and a new community, which is creating academic knowledge as an environmental solution. Amongst many new genres in the digital world, environmental humanities restarted its way back and grow along with the development of literature, philosophy, history, geography, gender studies and anthropology from 1970s. This Research Paper takes a look at how the environment humanities and their conceptualization of nature have begun to be incorporated into literature stories

Emergence of Environmental Humanities

The environmental humanities have been around for over a century. During the 1970s and 1980s, it developed in the field of the humanities as a result of the development of literature, philosophy, history, geography, gender studies and anthropology. In late 1990s, it was originally known as "ecological humanities" (Nye and Robert 3). It had been adopted in the field of postcolonial or feminist studies by Australian researchers.

Serpil Oppermann and Serenella Iovina in his introduction to " The Environmental Humanities and the Challenges of the Anthropocene"   remarks " The environmental humanities contextualizes and complements environmental science and policy with a focus on narrative, critical thinking, history, cultural analysis, aesthetics and ethics(1). Different perceptions exist, however, as to whether or not the humanities were given enough space at universities from 1960 onwards in a field that has already been established by an interterdisciplinary approach. " The roots of the environmental humanities traced back to some of the earliest cosmological narratives, stories and symbols among the world's oldest cultures" (5ed by Joni Adams Humanities for the environment). After many shortfalls in environmental crisis, especially in the case of climate change, many environmental activists and scientists begin to think more deeply about questions of " culture, language and narrative" (Heise 294). Environmental humanities is a term first suggested in Australia in 2011 by historian Libby Robin, ethnographer and literary critic Deborah Bird Rose and ecofeminist Val Plumwood, who formed a group to study the "ecological humanities"(Nye et al.). Thus the environmental humanities has become a global intellectual movement that reconciles the relationship between scientific disciplines and the humanities, which are essential to understand and resolve dilemmas that have been created by industrial society.

What is Environmental Humanities?

Despite the advent of digitalisation, ecological chaos needs to be dealt with in a holistic manner based on theory and practice. Although the digital world is home to a great many new genres, environmental humanities have come much earlier than that. In the 1970s and '80s, it was fueled by developments in literature, philosophy, history, geography, gender studies and anthropology. But, in the latter part of the twentieth century, Postcolonial and

Feminist studies had an influence on this field. They argued first of all that humans standing outside nature and controlling it are based upon a concept of the natural world, which they perceive as passive and feminine. The environmental humanities have become a global intellectual movement that examines the relationship between scientific and technical disciplines and the humanities, which are essential to understand and resolve dilemmas that have been created by industrial society.   However, a number of areas that contributed to the environmental humanities, in particular literature, cultural geography, anthropology, and history, had begun to bridge the gap between them and science half a century ago.

REVIEW OF LITERATURE

It has been over a decade since the New York Times declared the " Greening of the Humanities" (qutd in DeLoughrey and Handley 9), a remarkable shift that highlights the role of literature in mediating environmental knowledge and in articulating a poetics of place in the alienating wake of globalization. It has revitalised the humanities, providing a method of thinking about environmental history in terms of its complexity and imagining new directions for our ecological future. In the last decades, Genealogies in disciplines like anthropology, geography, literature, history, philosophy, and science and technology studies have contributed to developing discourses on ecofeminism, public ecology, and environment justice. On the whole, historians are better equipped to understand such global interconnections then scholars of literature. However, Jamaica Kincaid , Antiguan American novelist, essayist, gardener, and gardening writer, expressed her disappointment and amusement at the homogenisation of the natural world in the eighteenth century in her *My Garden Book* as follows: These countries in Europe shared the same botany, more or less, but each place called the same thing by a different name: and these people who make up Europe were (are) so contentious anyway, they would not have agreed to one system for all the plants they had in common, but these new plants from far away, like the people far away, had no history, no names, and so they could be given names (qutd in DeLoughrey and Handley 11).

Whereas, the British historian, Richard Grove points out as "green imperialism"(11 DeLoughrey and Handley), that is a process that foregrounds the etymological definition of diaspora as the spreading of seeds, and destabilizes our association of flora and fauna with a natural landscape. Vandana Shiva, an Indian environmental activist is linking the current practice of patenting life forms and indigenous knowledge to a binomial taxonomy for all global flora and fauna. This ecocritical turn in literary studies has produced an innovative body of scholarship, including an international conference association and multiple journals, scholars have lamented that the dominant discourse of the field continues to be marked by an Anglo - American and a national framework rather than engaging broader contexts. Actually, according to Rob Nixon's comments on the New York Times article celebrating this year's inauguration, all of the two dozen or so green authors cited are American.

Transdisciplinary projects in the Environmental Humanities have involved storytelling, semi -structured interviews and visual ethnography to develop usable models for directing energy development, agricultural practices, land use, and water management. The subfields in the Environmental Humanities are eco criticism, environmental philosophy and history, critical animal studies, queer ecologies, eco feminism, environmental sociology, political ecology, eco materialism and post humanism. Creative cooperation among humanities and sciences could therefore be encouraged by the pragmatic approach of the environmental humanities. New ways of thinking and new communities that produce environmental solutions as a form of academic knowledge are therefore needed in the context of the global environmental crisis. In that context, an issue of this research paper focuses on the development of ecological humanities in literature narrative and how they are recasting themselves into historical works. Paradoxically, as American ecocriticism expands and gains increasing relevance in the context, its major narrative threads are producing and nationalist genealogy origin. The fact that the ecological approach to literature is not restricted by geographical borders, language and nationality makes such a general lack of interaction with postcolonial methodologies and contexts peculiar. To foreground the literature's engagement the and the environment have been shaped by the history of empire. This ecocritical turn in literary studies has produced an

innovative body of scholarship, including an international conference association and multiple journals, scholars have lamented that the dominant discourse of the field continues to be marked by an Anglo - American and a national framework rather than engaging broader contexts. Actually, Rob Nixon makes it clear in his response to this glowing New York Times article that all the two dozen or so green authors mentioned are Americans.

Conceptualizing Nature

There's a great deal of literature that could be discussed, as human relations with the forest are an important part of much precolonial Indian thinking. Nature writing has been an integral theme in nineteenth and twentieth century literature, dating back to Upanishad times. E.M. Forster's *A Passage to India*, Rudyard Kipling's imprerialist adventure tales, travel narratives such as Colonel Burton's *Tigers of the Raj* or the man -eating tiger adventures of passionate jungle lover Jim Corbett. These writers from the West disagreed with a certain aspect of UK's assault on forests. In the post colonial era, nature writing in the South Asian Diaspora, of Indian nature writing writers like Rabindaranath Tagore, A.K.Ramanujan and Meena Alexander have synthesized Indian nature philosophy in the contexts of other continents. classics like Rabindranath Tagore's poetry, and R.K.Narayan's fiction have been a major influence on nature writing in the twentieth century. South Asian nature writing that describe the effects of British colonialism on India's forest communities: nature themes originating in paradigms of Independence for instance, the Chipko movement and the dichotomies of nature thought between Gandhi and Nehru: and contemporary literature that examines indigenous tribal, peasant and women's and men's issues in relation to their forest home.

In fact, the recent rich body of socially engaged poetics historically ties environmental degradation and structural discrimination to Indian cultural presenxuity in a postcolonial context, which is why an understanding of the socioecological outcomes of colonial policies and actions are essential for India. One legacy of European colonisation, which has not diminished with the postcolonial context, is that of environmental racism as VandanaShiva, Gail Omvedt, Ramachandra Guha, Madhav Gadgil, Mahaswetha Devi, Nina Sibal have all recently demonstrated. Along the list, one prominent writer from south India, Tamil Nadu is Kavery Nambisan, She takes all possible efforts to break the existing dogma of tribal women's image in pre- independence time. Similarly many literary works are informative by holding the historical events, tribal thoughts, customs, fashion, food practices, dedication towards their profession, mutual treatment of people, behavioural differences of mankind, bond with animals and nature, sociological and economical indifferences attempt to understand the perspectives of peculiar thinkers who clearly give a huge characterization of the mankind and its region. In order to make her characters and story more intense and effective, Nambisan is incorporating the place's pride, history and culture. To illustrate the changes in people's minds as time went on, she brought back traditional values and their existing attachment to it. Especially the novel, *The Scent of Pepper*, deals with the Kodava Clan, its customs for over hundred years. This notable work remains to be diplomatic in exposing the Kodava, their bond with nature and people's life in the pre-independent period. She discusses about the eternal beauty of Coorg, refreshing coffee vegetation, recovering pepper, the evergreen surface of the places and well cultured and nature bound kodava, yerava and kongetira clans. Her description of nature will make the readers feel like they're living among characters. It is easy for readers to get into the inner life, emotions, and thoughts of nature. It's always good to take a look at the web of connections, ideas and discussions that Environmental Humanities have in their respective fields.

CONCLUSION

Thus, environmental humanities cannot be a solitary practice; it can be widely collaborated across discipline, period and specialization as its lifeblood. This is why the environmental humanities therefore welcome new talent, but they do not control access to their experience or the community. In this context the humanities can be of greatest use in assisting scholars to draw up a list of myriad tales which have been forgotten by writers' voices. So the humanities can dig deeply into lost histories and find patterns for a future that is once again possible.

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RESEARCH ARTICLE

A Study on Solving Least-Cost Fuzzy Transportation Problem using MAT LAB

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ABSTRACT

Transportation problems are one of the improvised versions of linear programming. Least-Cost Method, which is used to calculate the transportation cost. This method is very useful for decision-makers. The objective of the article is to introduce MATLAB code for fuzzy transportation problems using the least-cost method to solve the fuzzy data and make the process easier. Because of insufficient or missing information, the available supply and anticipated demand are frequently fuzzy in real-world circumstances. This article proposes a MATLAB code for the least-cost fuzzy transportation problem.

Keywords: Fuzzy Transportation problem (FTP),Triangular Fuzzy Number, MAT LAB, Fuzzification, Defuzzification.

INTRODUCTION

The Transportation problem involves finding the minimum- cost plan for distributing stocks of goods or inventories from multiple origins to multiple destinations that demand the goods. The transportation model can be used to determine how to allocate the inventories available from the prismatic manufactories to the storages that stock or demand those goods, in such a way that total shipping cost is minimized. Generally, analysis of the problem will produce a shipping plan that pertains to a certain period of time (day, week), although once the plan is established, it'll generally not change unless one or further of the parameters of the problem (stock, demand, unit shipping cost)

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changes. In the area of Linear Programming Problem (LPP), modeling of Transportation Problem (TP) is essential in cracking most real life problems as far optimization is concerned. MATLAB is used for treating programming of LPP, a condition applied to as M- File that can influence from codes. The Paper discusses to study TP that would calculate the use of MATLAB codes using a fine modeling. The model develops the transportation result for the North West Corner Rule, Least Cost system, Vogel's Approximation methodology, and MODI methodology for the TP. It's clear that a lot of work has been involved in by numerous experimenters in interrogate about of applicable result styles to similar problem. Likewise, logical approach and MATLAB rendering are the styles used by utmost experimenters in the operation of these effective proposed ways. In this paper, an original MATLAB coding was written that would support in the calculation of similar problems with easiness especially when the problem at LPP and TP. For each model, we use a combination of logical methodology and MATLAB encrypting to study the easiest way that would be effective while find the result of different problems. MATLAB is the important computational tool in operation exploration. The MATLAB coding methodology is better than logical methodology for cracking TP. This methodology gives us reasonable result in Transportation problem.

MATERIALS AND METHODS

Least-Cost or Matrix Minima
Track: 1
Define the needed cost in the cost matrix of the transportation table. Let M_{ij} be a cost matrix. Allocation will be $x_{ij} = \min(a_i, b_j)$ in the cell (i, j).

Track: 2
If $p_{ij} = a_i$, cross off the ith row of the transportation table and reduction b_j by a_i. Then go to track 3.
If $p_{ij} = b_j$, cross off the jth column of the transportation table and reduction a_i by b_j. Then go to track 3.
If $p_{ij} = a_i = b_j$, cross off either the ith row or jth column but not one and the other.

Track: 3
Replication track 1 and 2 for the operating reduced transportation table until all the margin necessities are satisfied. Whenever the minimal cost isn't unique make an arbitrary choice among the minima.

Algorithm for Proposed Method
The proposed method's algorithm solves the fuzzy transportation problem by using MATLAB.
Step: 1 Define the variables of the Triangular membership function.
Step: 2 Defuzzification of the value by using the method centroid or bisector
Step: 3 Next, assign the values in the array as a matrix.
Step: 4 Apply the matrix value in the LCM Transportation Problem Code
Step: 5 Execute the code to get a better optimal solution.
Similarly, we can write about the trapezoidal membership function.

Fuzzification
Fuzzification is the process of making a crisp quantity fuzzy.

Defuzzification
The method of defuzzification involves taking a single number from the output of the combined fuzzy set. It is used to convert the findings of fuzzy inference into a clear output. In other words, a decision-making algorithm that chooses the optimal crisp value based on a fuzzy set achieves defuzzification. 'centroid', 'bisector', 'mom', 'lom', 'som'.

NUMERICAL EXAMPLE

Predefined variables in the program, using 3 × 4 matrix variables.

M-File 1

```
x = -30:0.1:30;
mf1 = trimf(x,[1 2 3]);
A1 = defuzz(x,mf1,'centroid')
mf2 = trimf(x,[5 7 9]);
A2 = defuzz(x,mf2,'centroid')
mf3 = trimf(x,[2 4 6]);
A3 = defuzz(x,mf3,'centroid')
mf4 = trimf(x,[1 3 5]);
A4 = defuzz(x,mf4,'centroid')
mf5 = trimf(x,[1 3 5]);
A5 = defuzz(x,mf5,'centroid')
mf6 = trimf(x,[0 1 2]);
A6 = defuzz(x,mf6,'centroid')
mf7 = trimf(x,[4 5 6]);
A7 = defuzz(x,mf7,'centroid')
mf8 = trimf(x,[2 4 6]);
A8 = defuzz(x,mf8,'centroid')
mf9 = trimf(x,[5 7 9]);
A9 = defuzz(x,mf9,'centroid')
mf10 = trimf(x,[0 1 2]);
A10 = defuzz(x,mf10,'centroid')
mf11 = trimf(x,[2 6 10]);
A11 = defuzz(x,mf11,'centroid')
mf12 = trimf(x,[1 2 3]);
A12 = defuzz(x,mf12,'centroid')
C=[ A1 A2 A3; A4 A5 A6; A7 A8 A9; A10 A11 A12];
s1 = trimf(x,[4 5 6]);
S1 = defuzz(x,s1,'centroid')
s2 = trimf(x,[4 8 12]);
S2 = defuzz(x,s2,'centroid')
s3 = trimf(x,[5 7 9]);
S3 = defuzz(x,s3,'centroid')
s4 = trimf(x,[9 14 19]);
S4 = defuzz(x,s4,'centroid')
supply=[ S1 S2 S3 S4];
d1 = trimf(x,[5 7 9]);
D1 = defuzz(x,d1,'centroid')
d2 = trimf(x,[5 9 13]);
D2 = defuzz(x,d2,'centroid')
d3 = trimf(x,[10 18 26]);
D3 = defuzz(x,d3,'centroid')
demand= [D1 D2 D3];
y=0;
while (~isempty(supply) && ~isempty(demand))
 M=min(C);
 N=min(M);
```

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```
  i=0;
 j=0;
 [i,j]=find(C==N);
X = min(supply(i(1)),demand(j(1)));
 y=y+X*N;
  if (X==supply(i(1)))
    C(i(1),:)=[];
    supply(i(1))=[];
    demand(j(1))=demand(j(1))-X;
  end
  if (X==demand(j(1)))
    C(:,j(1))=[];
    demand(j(1))=[];
    supply(i(1))=supply(i(1))-X;
  end
end
disp('The Least Cost of the given input matrix is :Rs.')
disp(y)
```

Result output of the MATLAB program

>> The Least Cost of the given matrix is: Rs.83

M-File 2

```
x = -30:0.1:30;
r11= input('');
r12= input('');
r13= input('');
r21= input('');
r22= input('');
r23= input('');
r31= input('');
r32= input('');
r33= input('');
r41= input('');
r42= input('');
r43= input('');
r51= input('');
r52= input('');
r53= input('');
r61= input('');
r62= input('');
r63= input('');
r71= input('');
r72= input('');
r73= input('');
r81= input('');
r82= input('');
r83= input('');
r91= input('');
```

```
r92= input('');
r93= input('');
r101= input('');
r102= input('');
r103= input('');
r111= input('');
r112= input('');
r113= input('');
r121= input('');
r122= input('');
r123= input('');
r131= input('');
r132= input('');
r133= input('');
r141= input('');
r142= input('');
r143= input('');
r151= input('');
r152= input('');
r153= input('');
r161= input('');
r162= input('');
r163= input('');
a11= input('');
a12= input('');
a13= input('');
b11= input('');
b12= input('');
b13= input('');
c11= input('');
c12= input('');
c13= input('');
d11= input('');
d12= input('');
d13= input('');
e11= input('');
e12= input('');
e13= input('');
g11= input('');
g12= input('');
g13= input('');
h11= input('');
h12= input('');
h13= input('');
k11= input('');
k12= input('');
k13= input('');
mf1 = trimf(x,[r11 r12 r13]);
A1 = defuzz(x,mf1,'centroid')
mf2 = trimf(x,[r21 r22 r23]);
```

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```
A2 = defuzz(x,mf2,'centroid')
mf3 = trimf(x,[r31 r32 r33]);
A3 = defuzz(x,mf3,'centroid')
mf4 = trimf(x,[r41 r42 r43]);
A4 = defuzz(x,mf4,'centroid')
mf5 = trimf(x,[r51 r52 r53]);
A5 = defuzz(x,mf5,'centroid')
mf6 = trimf(x,[r61 r62 r63]);
A6 = defuzz(x,mf6,'centroid')
mf7 = trimf(x,[r71 r72 r73]);
A7 = defuzz(x,mf7,'centroid')
mf8 = trimf(x,[r81 r82 r83]);
A8 = defuzz(x,mf8,'centroid')
mf9 = trimf(x,[r91 r92 r93]);
A9 = defuzz(x,mf9,'centroid')
mf10 = trimf(x,[r101 r102 r103]);
A10 = defuzz(x,mf10,'centroid')
mf11 = trimf(x,[r111 r112 r113]);
A11 = defuzz(x,mf11,'centroid')
mf12 = trimf(x,[r121 r122 r123]);
A12 = defuzz(x,mf12,'centroid')
mf13 = trimf(x,[r131 r132 r133]);
A13 = defuzz(x,mf13,'centroid')
mf14 = trimf(x,[r141 r142 r143]);
A14 = defuzz(x,mf14,'centroid')
mf15 = trimf(x,[r151 r152 r153]);
A15 = defuzz(x,mf15,'centroid')
mf16 = trimf(x,[r161 r162 r163]);
A16 = defuzz(x,mf16,'centroid')
C=[ A1 A2 A3 A4;A5 A6 A7 A8;A9 A10 A11 A12; A13 A14 A15 A16];
s1 = trimf(x,[a11 a12 a13]);
S1 = defuzz(x,s1,'centroid')
s2 = trimf(x,[b11 b12 b13]);
S2 = defuzz(x,s2,'centroid')
s3 = trimf(x,[c11 c12 c13]);
S3 = defuzz(x,s3,'centroid')
s4 = trimf(x,[d11 d12 d13]);
S4 = defuzz(x,s4,'centroid')
supply=[ S1 S2 S3 S4];
d1 = trimf(x,[e11 e12 e13]);
D1 = defuzz(x,d1,'centroid')
d2 = trimf(x,[g11 g12 g13]);
D2 = defuzz(x,d2,'centroid')
d3 = trimf(x,[h11 h12 h13]);
D3 = defuzz(x,d3,'centroid')
d4 = trimf(x,[k11 k12 k13]);
D4 = defuzz(x,d4,'centroid')
demand= [D1 D2 D3 D4];
y=0;
while (~isempty(supply) && ~isempty(demand))
```

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```
M=min(C);
 N=min(M);
 i=0;
j=0;
 [i,j]=find(C==N);

 X = min(supply(i(1)),demand(j(1)));
y=y+X*N;
 if (X==supply(i(1)))
   C(i(1),:)=[];
   supply(i(1))=[];
   demand(j(1))=demand(j(1))-X;
 end
 if (X==demand(j(1)))
   C(:,j(1))=[];
   demand(j(1))=[];
   supply(i(1))=supply(i(1))-X;
 end
end
disp('The Least Cost of the given matrix is: Rs.')
disp(y)
```

Result output of the MATLAB program
>> The Least Cost of the given matrix is: Rs.91

Suggestion
Run the m-file through MATLAB version R2021a.

CONCLUSION

This paper proposes a MATLAB code to solve matrix minima in a fuzzy environment. This method gives relatable cost from solving fuzzy transportation problem using defuzzification tool, simply known as converting fuzzy value into crisp value. From the numerical example, we get two types of data entry in the program: one is already written in the programme itself, and the other is that after running the program, we input the data to get the output. Here we use a (3, 4) and (4, 4) matrix of variables. In future we built more programs for different dimension of matrix. From this paper, we conclude that matrix minima, or fuzzy LCM, is optimum.

Conflict of Interest
All authors declare that there is no conflict of interest.

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Table-1. Pre defined variables in the program, using 3×4 matrix variables.

Destinations / Sources	D1	D2	D3	Supply
S1	[1,2,3]	[5,7,9]	[2,4,6]	[4,5,6]
S2	[1,3,5]	[1,3,5]	[0,1,2]	[4,8,12]
S3	[4,5,6]	[2,4,6]	[5,7,9]	[5,7,9]
S4	[0,1,2]	[2,6,10]	[1,2,3]	[9,14,19]
Demand	[5,7,9]	[5,9,13]	[10,18,26]	

Table-2

Destinations / Sources	D1	D2	D3	Supply
S1	[1,2,3]	[5,7,9] **[1,2,3]**	[2,4,6] **[1,3,5]**	[4,5,6]
S2	[1,3,5]	[1,3,5]	[0,1,2] **[4,8,12]**	[4,8,12]

S3	[4,5,6]	[2,4,6]	[5,7,9]	[5,7,9]
S4	[0,1,2]	[2,6,10]	[1,2,3]	[9,14,19]
	[5,7,9]		**[5,7,9]**	
Demand	[5,7,9]	[5,9,13]	[10,18,26]	

Table-3. After running the program, input the variables using 4 × 4 matrix variables.

Destinations / Sources	D1	D2	D3	D4	Supply
S1	[4,5,6]	[1,2,3]	[2,4,6]	[1,3,5]	[5,7,9]
S2	[2,4,6]	[4,8,12]	[0,1,2]	[2,6,10]	[10,12,14]
S3	[2,4,6]	[2,6,10]	[5,7,9]	[4,5,6]	[5,7,9]
S4	[0,0,0]	[0,0,0]	[0,0,0]	[0,0,0]	[16,19,22]
Demand	[20,22,24]	[2,6,10]	[4,5,6]	[10,12,14]	

Table-4

Destinations / Sources	D1	D2	D3	D4	Supply
S1	[4,5,6]	[1,2,3] **[2,6,10]**	[2,4,6]	[1,3,5] **[0,1,2]**	[5,7,9]
S2	[2,4,6] **[1,3,5]**	[4,8,12]	[0,1,2] **[4,5,6]**	[2,6,10] **[2,4,6]**	[10,12,14]
S3	[2,4,6]	[2,6,10]	[5,7,9]	[4,5,6] **[5,7,9]**	[5,7,9]
S4	[0,0,0] **[16,19,22]**	[0,0,0]	[0,0,0]	[0,0,0]	[16,19,22]
Demand	[20,22,24]	[2,6,10]	[4,5,6]	[10,12,14]	

RESEARCH ARTICLE

Synthesis and Characterization of Bivalent Metal Oxide Nanoparticles

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ABSTRACT

Nanosized biomaterials stand out in the material sciences as a result of their likely applications and benefits over different synthetic and actual methodologies. Metallic nanoparticles (metal or metal oxide nanoparticles) have accomplished wonderful prevalence because of their intriguing natural, physical, chemical, attractive, and optical properties. The natural strategy is liked as it gives a green, upfront, effortless, ecofriendly, quick, and savvy course for the green blend of nanoparticles. Plants have complex phytochemical constituents like sugars, amino acids, phenolics, flavonoids, terpenoids, and proteins, which can act as decreasing and balancing specialists. In the current work, we detailed a blend of nickel oxide nanoparticles utilizing a natural product plant extract of *Bauhinia variegata* by ethanolic extraction. The nanostructures of the examples were portrayed utilizing UV-Visible spectroscopy, Fourier transform infrared red spectroscopy (FT-IR), X-ray diffraction (XRD) and Scanning electron microscopy (SEM). The spherical nature and size of nickel oxide nanoparticles were found at 151 nm to 217 nm.

Keywords: Nanotechnology, Nickel oxide, *Bauhinia Variegata,* FTIR, XRD, SEM

INTRODUCTION

Nanoparticles (NPs) are typically spherical particles with dimensions between 1-100 nanometers [1]. In order to gain access to new classes of functional materials with unheard-of features and uses, researchers have extensively studied nanostructured materials [2]. Conductive paints [3] , rechargeable batteries [4], chemical catalysts [5], optoelectronics [6], magnetic recording medium [7], ferrofluids [8], contrast-enhanced magnetic resonance imaging [9–11] and other applications all make use of magnetic nanoparticles. Improved biological therapy, wastewater treatment, and environmental remediation all greatly benefit from nanotechnology. Due to their chemical, physical, electrical,

catalytic, and optical properties, nanoparticles can act as a possible catalyst in the oxidation process to purify industrial sewage water [12–13]. Due to their applicability in a variety of fields, bimetallic nanoparticles have recently attracted a lot of attention. Their value stems from unique characteristics that set them apart from monometallic nanoparticles. It has been previously reported [14-15] that the synthesis of Cu-Ni alloy nanoparticles in a 1:1 ratio was achieved utilizing the micro emulsion technique, sodium dodecyl sulfate and oleic acid. One of the transition metals, nickel, exhibits magnetic properties as a bulk substance in addition to having a number of other intriguing characteristics and uses, including catalysis and the storage of hydrogen. The literature contains techniques for creating nickel nanoparticles, including electrochemical reduction [16], chemical reduction [17] and sol-gel [18]. Nickel nanocrystals, which are magnetic transition metal nanoparticles, are challenging to make because they are easily oxidized. Several techniques were used in organic media to produce pure nickel nanocrystals in order to prevent the production of oxide or hydroxide. Nickel oxalate has been thermally decomposed at 450 °C to produce nickel oxide nanoparticles. Thermal decomposition is a novel way to generate stable, mono dispersed materials among the several techniques discovered for the manufacture of nickel and nickel oxide nanoparticles [19], and it is a rapidly growing field of study. It is quicker, cleaner, and more cost-effective than the traditional process. To expand the application areas and meet the demands of basic research, the thermal reduction technique should be improved in order to produce nickel nanoparticles with adjustable size and form. A drunkard concentrate of *B. variegata* stem bark has shown critical hepatoprotective activity against liver harm brought about via carbon tetrachloride [20]. With the improvement of nanotechnology, nanoparticles (NPs) have been broadly utilized in industry, farming, medication, and day-to-day existence. Carbon nanotubes, polymeric nanoparticles, metallic nanoparticles, microbially combined nanoparticles, liposomes, and attractive nanoparticles are among the most studied nanostructures for biomedical applications in disease treatment and analysis. Amalgam NPs, for example, were effectively created for malignant growth theranostics [21].

The aim of this study, green synthesis of Nickel oxide nanoparticles from *Bauhinia varigetae* plant fruit extract. At first, was to investigate effect of several experimental parameters on the size of nickel oxide particles and determination of best experimental conditions for synthesis of Nickel oxide (NiONPs) nanoparticles in aqueous media. Therefore, a statistical experiment design procedure was used to investigate effects of four parameters on the size of formed particles including concentration of metal ion solution, plant extract concentration, pH and temperature of the reaction. Synthesized nickel oxide nanoparticles characterized by UV-Visible spectroscopy, Fourier transform infrared spectroscopy, X-ray diffraction and Scanning electron microscopy.

MATERIALS AND METHODS

Collection of *Bauhinia variegata* Plant Material
The *Bauhinia variegata* fruit samples were taken at the Pudukkottai, Tamil Nadu, India, campus of the J.J. College of Arts and Science, were properly cleaned with double distilled water after being washed numerous times with tap water to get rid of unwanted material. To remove moisture content, the cleaned *Bauhinia variegata* fruit were completely dried at room temperature in the open air under shade for 15 days. An electrical grinding device was used to crush the dried fruit of the *Bauhinia variegata* plant fruit and create a fine powder.

Chemicals and Reagents
The chemicals and reagents, which included Ethanol (C_2H_5OH), Nickel Chloride ($NiCl_2$), Sodium Hydroxide (NaOH), Hydrochloric Acid (HCl), and double distilled water (DDW) were bought from Sigma Aldrich, Pvt Ltd and utilized without further purification. The chemicals employed in this study were all of the analytical variety.

Preparation of Extract for Phytochemical Screening

The *Bauhinia variegata* fruit that had been harvested was washed twice: once with tap water to get rid of the dust, and once with distilled water. In a 250-ml beaker, 10 g of leaves were combined with 100 ml of sterile, decanted water. The mixture was then heated for 5 minutes and allowed to cool to room temperature (30°C). The cooked mixture was then processed through Whatman filter paper No.1 after being coarsely ground in a kitchen grinder. The filtrate was used to form nanoparticles of nickel oxide.

Synthesis of Nanoparticles
Preparation of Plant Extract (Reducing Agent)

*Extracts were prepared by taking 20 gm of *Bauhinia varigata* fruits, washing them thoroughly with double-distilled water, and cutting them into fine pieces. Then, the pieces are boiled in 100 ml of double-distilled water for 20 minutes at 60 °C in a glass beaker. After boiling, the extract was filtered using Whatman No. 1.

Preparation of Metal Solution (Precursors)

Precursors for Nickel nanoparticles ($NiCl_2$) were purchased from Sigma Aldrich, Pvt Ltd, and prepared freshly. The precursor for preparing nickel nanoparticles was 5mM of nickel chloride using double-distilled water.

Synthesis of Nickel Oxide Nanoparticles

To produce nickel oxide nanoparticles, a precise mixture of 10 ml of extract and 90 ml of nickel chloride solution at a concentration of 5mM was used (1: 10). The transition from green to dark brown was a sign that nickel oxide nanoparticles (NiONPs) was being synthesized. The purified NiONPs was washed with sterile distilled water at 10,000 rpm for 20 minutes in a cooling centrifuge. The pellet was gathered and put away for examination.

Characterization of the Synthesized Nickel Oxide Nanoparticles
UV-Visible Spectroscopy

Ultraviolet-visible spectroscopy (UV-Vis) submits to absorption spectroscopy in the UV-visible spectral area. The nickel nanoparticles were characterized in a Perkin Elmer Lambda 35 UV-vis spectrophotometer. Because the scanning range for the samples is 200–1100 nm, the double-distilled water is used as a blank reference.

Fourier transfer infrared spectroscopy (FTIR)

The nanoparticles were characterized using a Perkin Elmer Spectrum Two Infra-Red Spectrophotometer. Two milligrams of the sample were mixed with 100 mg of potassium bromide (KBr). Once compressed to prepare a salt disc roughly 3 mm in diameter, the discs were at once kept in the sample holder. The FTIR spectra were recorded in the absorption range between 4000 - 400 cm^1.

X-ray Difraction Analysis (XRD)

The particle size and nature of the nickel nanoparticles were determined by using the XRD. This was done using the Shimadzu XRD–6000/6100 model with 30 kV and 30 mA with Cuk radians at a 2 angle. X-ray powder diffraction is a fast analytical technique. This is chiefly used for phase identification of a crystalline material and can supply information on unit cell dimensions. The analyzed material is thinly ground, and the normal bulk composition is established. The particle or grain size of the nickel nanoparticles was determined using Debye Sherrer's equation.

$$D = 0.94 / B \cos\theta$$

Scanning Electron Microscope Analysis (SEM)

The SEM is a kind of electron microscope (Carl Zeiss EVO 18) that images a sample by scanning it with an elevated energy beam of electrons in a raster scan model. This film of the sample was prepared on a carbon-coated nickel grid by just dropping a very small amount of the sample on the grid. The extra solution was removed with a blotting paper, and then the films on the SEM grid were permitted to dry by putting them below a mercury lamp for 5 minutes.

RESULT AND DISCUSSION

Phytochemical Screening

Preliminary phytochemical screening of the *Bauhinia variegata* fruit extracts was tested for alkaloids, flavonoids, saponins, terpenoid tannins, carbohydrates, and steroids. The choice of these extracts was based on their highest potency against antimicrobial activity. The results are indicated as (Positive) for the presence and (Negative) for the absence of phytochemicals.

Effect of Various Parameters on formation of NiONPs

The form and size of the nickel nanoparticles are influenced by a number of characteristics that might change during the formation of nickel oxide nanoparticles. Hence, a factorial design of trials using the "one factor at a time" strategy has been used to determine the ideal circumstances. The investigative elements in this case were altered one at a time, while the remaining components remained the same [22]. Temperature (26℃, 40℃, 50℃, 60℃, and 70℃), salt concentration (1mM, 2mM, 3mM, 4mM, and 5mM) [23]. pH (pH5, pH6, pH7, pH8, and pH9) [24] and plant extract (1:10, 2:10, 3:10, 4:10, and 5:10) were evaluated [25] as the best conditions to maintain minimum polydispersity in nickel oxide nanoparticles.

Characterization Study of Nickel Oxide Nanoparticles
UV-Visible Spectroscopy

The characteristic's most extreme frequency was resolved utilizing a bright noticeable (UV-visible) spectrophotometer at a large number of frequencies from 200–1100 nm. The UV-visible spectra of nickel oxide nanoparticles were recorded on a Perkin Elmer Lambda 35 reflectance spectrometer at room temperature [26]. UV-visible investigation of *Bauhinia variegata* extricate shows two characteristic ingestion groups at 218 nm and 257 nm; in any case, after being dealt with metal arrangement with *Bauhinia variegata* separates, the retention groups were found to move to 206nm and 214nm because of surface plasmon, which means the formation of nickel oxide nanoparticles (NiONPs). It likewise implies that the organic product separate goes about as a diminishing specialist and may cause the decrease of the nickel.

Fourier- Transform Infrared Spectroscopy (FTIR)

The FTIR study revealed the interaction sites of extract molecules with nickel metal ion to form NiONPs. The FTIR spectra of *Bauhinia variegata* powder and synthesized NiONPs showed several peaks in the spectral range of 4000-400cm^{-1}shown in figure 3a and 3b, indicating the presence of the Phyto molecules from the extract on the surface of NiONPs, which confirms the stabilizing role played by the Phyto molecules in the synthesis of NiONPs. The strong broad peak at 3409 cm^{-1} was attributed to (O–H) alcohol present at the surface of NiONPs, medium peaks at 2922 cm^{-1}, 2853 cm^{-1}, were due to alkane C-H stretching of the alkane group. The strong band around 1266 cm^{-1} was assigned to the bridged form of any aromatic amine group (C-N), The strong peak at 1115cm^{-1} due to C-O stretching of aliphatic group, the strong peak at 1064cm^{-1} due to C-O stretching of primary alcohol, the strong peak appeared at 875cm^{-1} due to C-H stretching of 1,3 disubstituted [27].

XRD analysis of Nickel Oxide Nanoparticles

The crystallographic structure of NiONPs was revealed by X-ray diffraction (XRD) analysis. An XRD pattern was recorded by Tescan Oxford diffractometer with an operation voltage of 45 kV at 30 mA using Equation (1).

D=kλ/βcosθ   **—— (1)**

Where D=the crystsllite size of NiONPs, λ=the frequency of x-beam source (1.54059 nm) utilized in XRD, β=the full width at half limit of the diffraction top/, K=the scherrer's steady with esteem from 0.9 to 1, θ= the Bragg point. The crystalline nature of NiONPs was revealed by X-ray diffraction analysis. The diffraction peaks with 2θ degrees at 23.97, 35.53, 50.92, and 67.12 corresponded to the (300), (311), (211), and (112), Bragg's reflections of the simple cubic (SC) crystalline structure of Nickel oxide, respectively. XRD analysis result shows average nano-size range about 27nm using Scherrer's equation.

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Scanning Electron Microscope analysis of Nickel oxide nanoparticles

The morphology of NiONPs was presented by SEM analysis. The NiONPs were homogenized by an agate mortar. The surface morphology of cobalt oxide NPs was investigated by SEM, and the response is shown in Fig. 5. It is obvious from the SEM image that the particles were spherical in shape and agglomerated with an average size of 181 nm. Agglomerations in the particles depend upon the nature of the extract and the compounds present in the extract.

CONCLUSION

The Nickel oxide nanoparticles were successfully synthesized by using novel *Bauhinia variega*te plant fruit provides cost effective, easy and proficient way for synthesis of NiONPs. The functional group present in the fruit extract was confirmed by FTIR analysis. These functional groups were mainly responsible for the reduction of nickel metal ions into NiONPs. The synthesized nickel oxide nanoparticles were analyzed using UV-spectrophotometer, FITR, XRD and SEM

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Table.1. Preliminary phytochemical screening extract of *B.Variegata* fruit

S.No	Chemical group	Result
1.	Alkaloids	Positive
2.	Flavonoids	Positive
3.	Saponins	Negative
4.	Terpenoids	Positive
5.	Tannings	Positive
6.	Carbohydrates	Positive
7.	Protein	Negative
8.	Steroids	Positive
9.	Phenols	Negative

Table.2.FT-IR analysis of powder and synthesized NiONPs of *Bauhinia variegata*

S.No	Frequency (cm⁻¹)	Chemical bond	Phytoconstituents present	Peak Observed (B.Variegata Powder)	Peak Observed (NiONPs)
1	3850-3500	O-H Stretch	Hydroxyl group	3416	3406
2	3000-2850	C-H Stretch	Alkanes	2922	2921
3	3000-2850	C-H Stretch	Alkanes	2852	2850
4	1650-1550	C-H bend	Aromatic amine	-	1630
5	1320-1000	C-N Stretch	Aromatic amines	-	1264
6	1390-1350	C-O Stretch	Aliphatic	1364	-
7	1320-1000	C-O Stretch	Primary alcohol	1222	1064
8	910-665	C-H bend	1,3 Disubstituted	875	879
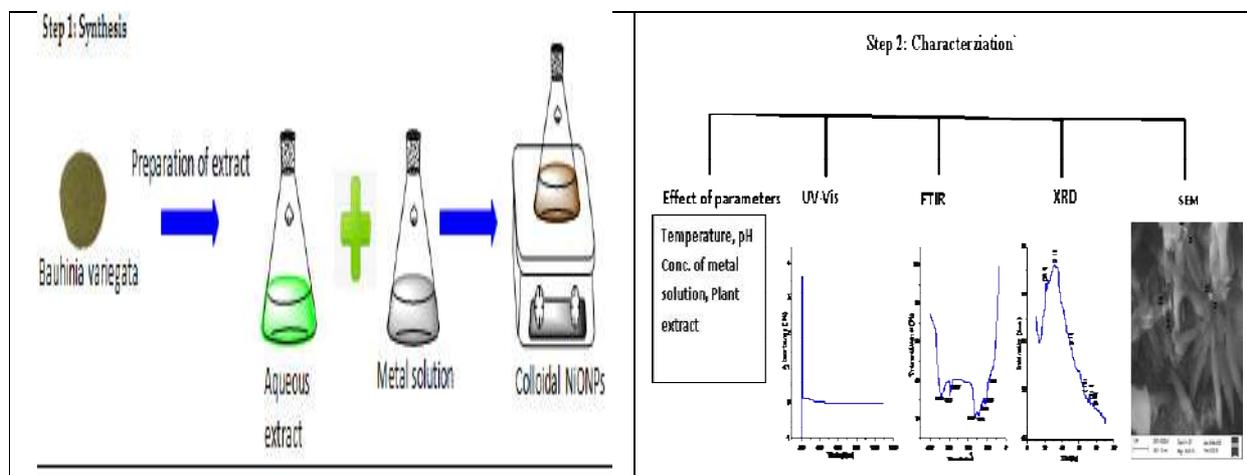
Fig. 1. Flow chart of synthesis of Nickel Oxide Nanoparticles

Fig.2a. UV-Visible Spectrum of Bauhinia variegata fruit extract

Fig.2b. UV-Visible Spectrum of NiONPs of Bauhinia variegata
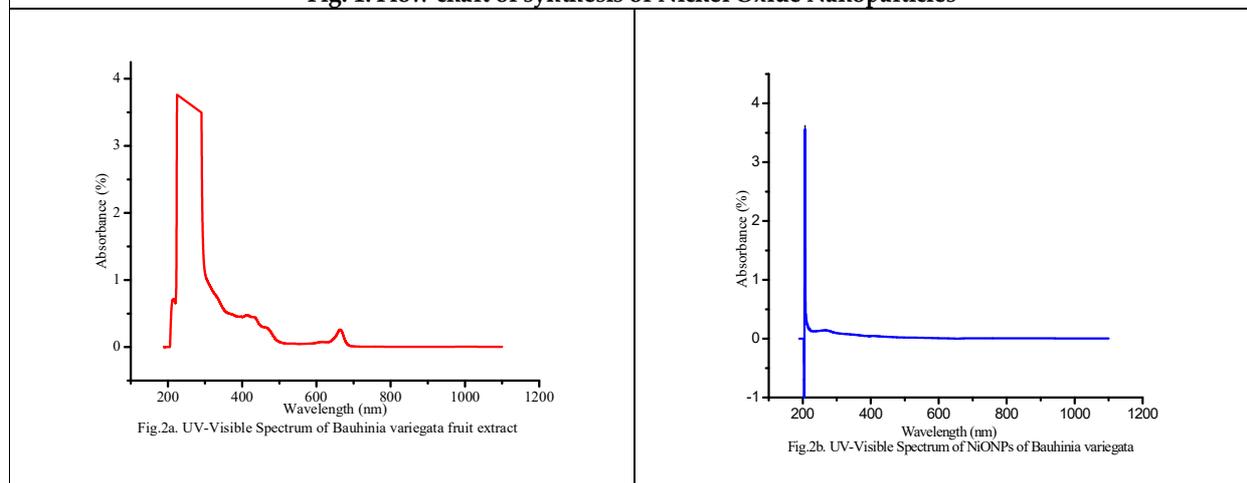
Fig.2 : UV-Visible Spectroscopy

Fig.3a.FT-IR spectrum of Bauhinia variegata fruit powder

Fig.3b.FT-IR spectrum of NiONPs of Bauhinia variegata
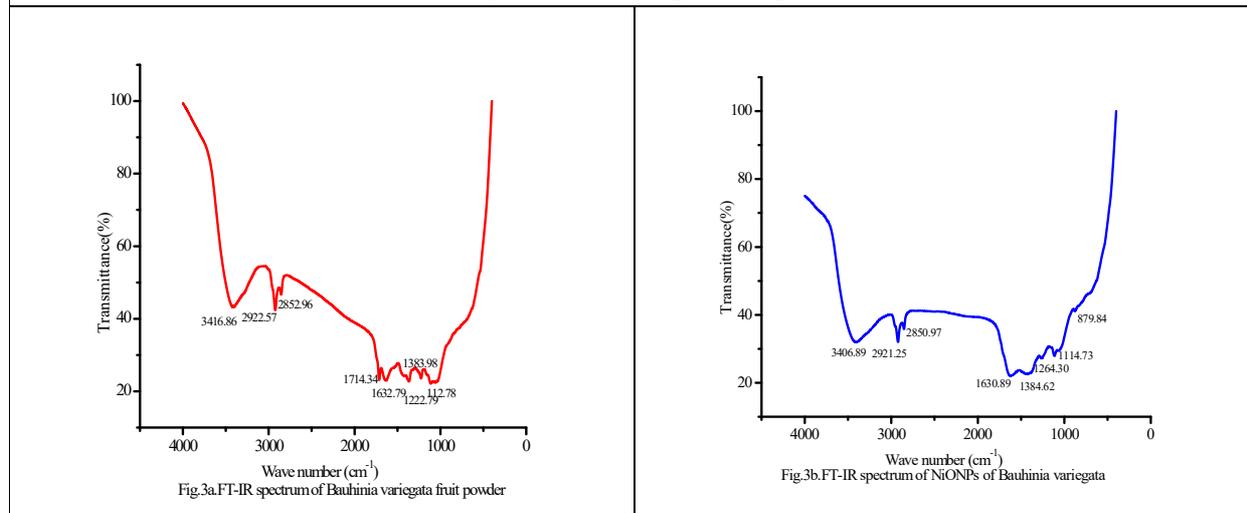
Fig.3 Fourier- Transform Infrared Spectroscopy (FTIR)

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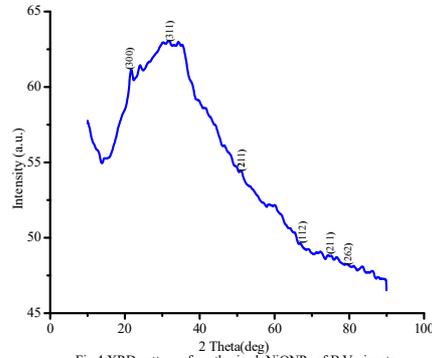
Fig.4.XRD pattern of synthesized NiONPs of B.Variegata

Fig.4 XRD pattern
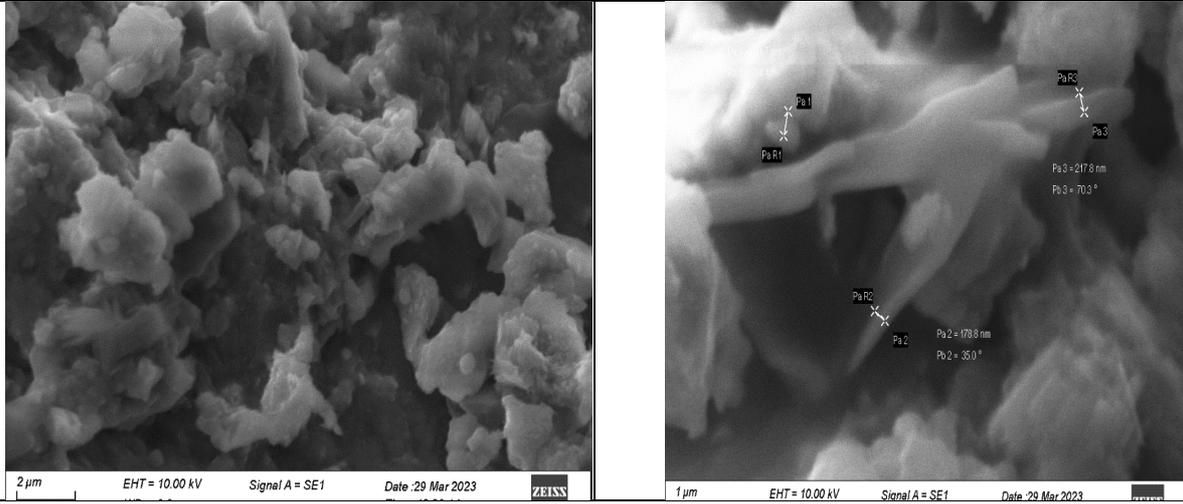
Fig.5. SEM images of NiONPs of *Bauhinia Variegata*

RESEARCH ARTICLE

A Study to Compare Immediate Effect of Sub occipital Muscle Inhibition Technique Versus Doming of Diaphragm on Hamstring Flexibility in Computer Workers

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ABSTRACT

Hamstrings are the group of muscles present in the posterior compartment of the thigh. It is found that this muscle has tendency to get tight in people undergoing prolonged sitting such as college students. It is evident that reduced flexibility of hamstring can be the source of low back as well as neck and shoulder pain. Also, tight hamstrings can alter the posture and increases the risk of injury. The study focuses on comparing the effectiveness of sub occipital muscle inhibition technique versus doming of diaphragm on hamstring flexibility in computer workers. A total number of 120 individuals were selected for the study. Participants with Pop lite al angle (PA) <125 degrees or forward flexion distance > 5cm were included. They were divided into two groups of 60 each. Group A was given SMI technique for 4 minutes and Group B was given DD approach for 5 minutes. Pre- and Post- Hamstring flexibility was assessed by using Active Knee Extension (AKE) test (right and left), Straight leg raise (SLR) test (right and left) and Modified sit and reach test (MSRT). Kolmoorov -Smirnov test was used to check the normality of the data. Wilcox on Signed Rank test was used for within group comparison for AKE and paired-t test was used for SLR a nd MSRT in Group A. For Group B, Wilcox on Signed Rank test was used for outcomes AKE and SLR and paired t-test was used for MSRT. Mann-Whitney U test was used for between group comparisons of mean difference between pre- and post- data in both the groups.

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In within group comparison, p- value of Group A and Group B is (<0.001) for AKE (right and left), SLR (right and left) and MSRT. While in between group comparison, p- value is (>0.05) for AKE and SLR but for MSRT, p-value is (<0.001). This study concludes that SMI technique as well as DD approach is found to improve hamstring flexibility, but SMI technique was found superior to DD approach for targeting posterior chain flexibility.

Keywords: Hamstring flexibility, DD approach, SMI, AKE, MSRT.

INTRODUCTION

Body of the human is an astounding machine. It is designed for long-term mobility as well as an incredible ability for compensating and adaptation. The fascial, or connective tissue matrix, is a key component of compensation. Fascia is an ongoing matrix of connective tissue linking numerous body's organs together.[1] Muscles inside the human body are broken down into three categories: skeletal, smooth, and cardiac. Histologically, skeletal as well as cardiac muscles are known as striated muscles, because muscle fibers seem striated underneath light microscopy. In general, there are two types of muscle fibers: type I and type II, often known as slow-twitch and fast twitch fibers, respectively.[2]Hamstrings consists more type II fibers than quadriceps or adductor magnus, according to Garrett et al. published well acknowledged examination of cadaver specimens (1984), who hypothesized this muscle composition may be a factor in the hamstrings' high susceptibility to strain injuries. It is assumed that fibers type II are highly vulnerable to strain injury since they are recognized to be more susceptible to break down following lengthening contractions. [3]Complex of hamstring musculature is situated in fascial region of rear thigh, consisting biceps femoris over the outer side and semi membranosus and semi tendinosus over inner side. These muscles are distinctively noticeable as they are two joint muscles, crossing both the femoroace tabular and tibiofemoral joints. The hamstrings have a crucial function in the gait cycle during activities like running and walking as they operate as the knee flexors and hip extensors. Hamstrings restricts knee extension just prior but also throughout initial contact ,offering dynamical support to antero - posterior translatory movement of tibia in reference to the femur in conjunction with the anterior cruciate ligament's static support (ACL).[4]Flexibility refers to capacity of a muscle to elongate, permitting number of joints to traverse through ROM. It is described as the ability to move one or more joints comfortably and without experiencing any pain. In order to minimize or prevent injury, flexibility enables the tissue to respond to tension more quickly, disperse force impaction, and enhance movement's effectiveness and efficacy.[5] One of the muscles that are most frequently tight is the hamstring. The hamstring muscle is the one that suffers the most damage in the human body, crossing multiple joints along with considerable functional excursion and numerous muscle fiber type II. [5] This gives rise to postural variations at pelvic region giving rise to posterior tilting and flat back posture. [6] A higher amount of stress on the spinal soft tissues is found due to the reduced lumbar curvature which is result of reduced pelvis mobility caused by hamstring muscle shortening. As a result, it has been demonstrated that inadequate hamstring flexibility alters typical biomechanical patterns, impacting balance, functionality, and athletic performance. It also reduces mobility, results in postural deviations, discomfort, and raises the risk of injury. [7]Several studies have linked a shortening of the hamstrings to an increased risk of hamstring strain. Reduced hamstring extensibility can also cause low back pain because the shortened hamstrings will pull the pelvis into posterior direction, resulting in the compensations of the spine. [8]Current Indian information technology (IT) and IT-enabled sectors already employ over 2 million people, and this figure is rising daily. Many musculoskeletal conditions and discomforts, together referred to as work-related musculoskeletal illnesses, have sedentary labour as their primary contributing factor (WRMSD).

Sedentism is a significant risk factor for several manageable illnesses that impairs quality of life. Muscle stiffness, reduced joint range of motion, and diminished flexibility are all side effects of a sedentary lifestyle that may interfere with daily activities. A person who spends their entire day sitting down, like students or desk-job workers, experiences accommodative substitutes which may shorten their hip muscles. Long periods of sitting cause the

pelvis to tilt, that leads to shortening of hamstring.[9]There are numerous techniques which are being used for enhancing muscle elasticity. Although stretching has long been utilized to promote extensibility, analysis found no evidence that it can be used as a stand-alone approach for preventing hamstring injuries.[6] Soft tissue mobilization, my of as cial release techniques, muscle energy technique, as well as other new interventions for enhancing flexibility are being researched for immediate impacts on hamstring flexibility. Interestingly, a prior study found that greater hamstring muscle tension and shortening can induce neck and shoulder pain. This happens because the cervical spine's soft tissue binds the dura and sub occipital muscular fascia, and the my of as cial chain's "superficial back line" unites neck to lower body. So, if sub occipital muscles' tone is diminished (passively, through a fascial therapy, or through active motions), it is likely that hamstring muscles' tone will also get reduced and the extent of hip flexion or knee extension would increase10]A recent study found that an intervention targeting the sub occipital muscles improved hamstring flexibility.[11] A manual technique called the sub occipital muscular inhibition (SMI) approach aims to ease up the tight sub occipital muscles by reducing my of as cial constriction in the area.[12]Since the sub occipital muscles include a high concentration of neuromuscular bundles, relaxing the muscle fascia promotes greater stretching and lowers knee flexor tone. It is true because a single neural pathway via the dura mater binds hamstrings along with sub occipital muscles. This was dubbed as "superficial back line" by Myers. [13]Other researchers looked at hamstring elasticity while taking into account postural muscle constraints, including the diaphragm. The diaphragm is such muscle with a trefoil-shaped tendon at its middle that blends seamlessly through the fibrous pericardium. Lumbar vertebral bodies, arcuate ligaments, costal margins, and xiphoid process constitute where the diaphragm originates from.[7]The diaphragm doming (DD) method is utilized to improve the diaphragm's function and restore its normal movement. The body acts as a dynamic system not as a discrete part whilst implementing kinetic chain techniques, which are focused on movement patterns. A diaphragm technique can influence remote structures like the hamstring muscles since there is a biomechanical connection seen between diaphragm and other structures.[7] Given the diaphragm's intricate structure and essential part in the postural chain's biomechanics, our hypothesis is that a technique for normalizing the diaphragm could have an effect on the posterior muscle chain. There is dearth of evidences for the effectiveness of both the techniques. So, this study was carried out to compare both techniques and determine whether one is superior to the other, which could be an alternative option. The goal of the current study was to evaluate the efficacy of the Sub occipital Muscle Inhibition Technique versus Doming of Diaphragm Approach for increasing hamstring flexibility in computer professionals.

MATERIAL AND METHODOLOGY

Design

This was a randomized clinical trial (pre and post intervention). Based on a previous study done by Érika Quintana Aparicio et al[12] , the size of the effect (5.03˚) and the SD (9.58) for the Straight Leg Raise (SLR) test of left side, for an α value of .05 and a statistical power of 0.84, revealed that the size of each group should be 57 subjects. The study confirmed to the guidelines of the Instututional Ethics Committee for Human Research – Sainath Hospital, Ahmedabad (IECHR-SAINATH HOSPITAL/AHMC/47). All subjects signed an informed consent form before their inclusion.

Subjects

The study included 120 participants (92 males) with a mean age of 42.51 ± 5.21 years. The subjects were from ABB INDIA LIMITED (68 subjects randomized between both groups) and REMARK ADVERTISEMENTS (52 subjects randomized between both groups).Inclusion criteria[8,14] were as follows: (1)Participants who gave informed consent; (2) Age group between 35-55 years; (3) Gender: both male and female; (4) Computer workers with work experience of at least 7 consecutive years, with extended sitting for a minimum of 5 hours/day; (5) Participants having hamstring tightness with PA<125 degrees or forward flexion distance test of more than 5 cm. Subjects with following criteria were excluded from the study [5,6,14] : (1) History of neck trauma; (2) Previous history of fracture or trauma or fracture of lower limb; (3) History of herniated disc or lumbar protrusion; (4) History of acute neck and

back pain; (5) History of pain, paresthesia in lower limb; (6) History of muscle tendon lesions of hamstring muscles (tendonitis, elongations, muscle tears) atleast one month before study; (7) Subjects using medication that could affect the measurement (e.g.: muscle relaxants); (8) Pregnant lady; (9) Received any manual therapy within the previous month.

Evaluations

Hamstring flexibility was assessed pre- and post- intervention using following three outcome measures. *ACTIVE KNEE EXTENSION TEST:*[11]Active knee extension was measured with gonio meter while the subject was in supine lying with hip stabilized at 90 degrees flexion. The gonio meter was placed in such a way that non movable arm was aligned along the femoral shaft pointing greater trochanter and the movable arm along tibial shaft pointing the lateral malleolus with lateral knee joint-line as a fulcrum. The participants were asked to extend the testing knee actively as much as possible. Then the knee flexion angle (popliteal angle) was measured using goniometer. Three readings were taken for active knee extension of which average was calculated. Bilateral measurements were taken. The test and retest measurement reliability coefficients for right and left extremities is .99. The hamstring is considered tight if the angle is less than 125 degrees. *STRAIGHT LEG RAISE TEST:*[15]Another frequently used test to check hamstring flexibility is the SLR test. In this test, the subject lies in supine position and the fibular malleolus, was marked with a marker. Goniometer's axis was aligned with the projection of the greater trochanter of the femur. Goniometer's stationary arm was kept parallel to the table. Knee and ankle were always extended. Holding the talus and not rotating the hip, the subject's lower limb was gradually raised until he/she complains of stiffness or soreness in the thigh region, bents his/her knee, or begins to swing the pelvis in retroversion. The movable arm of the goniometer was then pointed in line with the fibular malleolus, and the degree of straight leg elevation was recorded. Bilateral assessment was done. The hamstring is considered tight if this angle is less than 80 degrees. It has high interobserver reliability (0.94-0.96).made box with a measure tape (inch tape) affixed to the top was used to administer the test (Figure 1). The box had a 33 centimeter height. *MODIFIED SIT AND REACH TEST:*[16,17]A specifically made box with a measure tape (inch tape) affixed to the top was used to administer the test (Figure 1). The box had a 33 centimeter height.

Stage 1

The MSRT was calculated by measuring the finger-to-box distance in accordance with the methods outlined by Hoeger et al, compensating for the proportional disparities between arm and leg lengths. The subject was positioned on the floor with their feet flat against the box and their head, back, and hips against the wall (90 degrees at the hip joint). Only scapular abduction was permitted in this position, which also required the subject to place hands over hands and extend their arms outward until they were level with the measurement scale. When the feet were resting against the box, the finger-to-box distance (FTB) was calculated as the distance between the fingertips and that location (point 15 of the scale).

STAGE 2:

Sit and reach score (SRT score) is measured following the measurement of FTB distance. For this, the subject was positioned on the floor with their feet flat against the box and their legs fully extended, shoulder width apart. The participant placed one hand on top of the other with their knees completely extended. They steadily reached forward as far as they could without jerking, sliding their hands across the ruler's top, and kept that posture for at least two seconds. The final location of the fingertips on or toward the ruler was recorded as the SRT score in centimeters. Then after, MSRT score was calculated using the following equation: MSRT score = finger-to-box distance (cm) + (SRT score – 15 cm).The test was performed twice, and the average retained.

INTERVENTIONS

Group A (Sub occipital Muscle Inhibition Technique) (Figure 2)

The SMI technique was employed as a treatment and was carried out according to the literature.

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The participants were positioned in a supine position. The therapist was seated at the head end of the patient with both palms under the participant's heads, touching the evaluator's index, middle and ring fingertips with MCP joints in 90 degrees of flexion between the second cervical vertebra's spinous process and the occipital condyles. Following that, painless and steady pressure was applied upward and towards the therapist for 4 minutes, or until relaxation of tissue of sub occipital region was attained. The subjects were requested to keep their eyes close during the procedure to avoid movements of the eye that can alter the tone of the sub occipital muscles [4,15].

Group B (Doming of Diaphragm approach) (Figure 3)
The diaphragm doming is a technique for relaxing the diaphragm's resting condition and improving its contraction and relaxation functions. Its purpose is to improve the expiration phase by increasing the pressure gradient between the thorax and the abdomen. The subject was in supine lying position. The therapist was facing the subject and wrapped her hands around the subject's thoracic cage, slipping her fingers beneath the costal edges. After that, the thorax was carefully rotated to the left and right to see which orientation provides the most mobility and ease of motion. The thorax is eased in the direction of more free rotation. The hands were utilized to support and follow the tissues as a gentle release throughout this position, which was held for 5 minutes [14].

STATISTICAL ANALYSIS

The collected data were analyzed using SPSS version 26.0. Kolmogorov-Smirnov test was used to check the normality of the data. For Group A, Wilcoxon Signed Ranks test was used for within group comparison of AKE. For SLR and MSRT, paired t-test was used for within group comparison. For Group B, Wilcoxon Signed Ranks test was used for AKE and SLR. For MSRT, paired t-test was used for within group comparisons. Mann-Whitney U test was used for between group comparisons of difference of pre- and post- means.

RESULTS

The total sample included 120 subjects, of which 60 were assigned to Group A, whereas other 60 were included in Group B. The age of the individuals ranged between 35 and 55 years, with a mean of 41.88 ± 4.77 in Group A and 43.15 ± 5.66. The sample comprised total of 92 men and 28 women. Table 1 shows the characteristics and comparisons of the 2 study groups at the beginning of the study (pre-intervention between-group analysis— baseline). (Graph 1 and 2)Table 2 shows within group comparisons in Group A and Group B for pre- and post- data of AKE (right and left), SLR (right and left) and MSRT. Results suggests statistically significant (p-value <0.001) improvement in hamstring flexibility in both the groups. (Graph 3)Table 3 shows between group comparisons of difference of means of pre- and post- values of AKE (right and left), SLR (right and left) and MSRT in both the groups by using Mann Whitney U test. Results shows statistically insignificant (p-value > 0.05) difference between both groups for outcomes AKE (right and left) and SLR (right and left), but statistically significant (p-value <0.001) difference between groups for MSRT. So, significantly greater improvement was observed in Group A for MSRT than in Group B. These statistics shows that both techniques are equally effective in improving hamstring flexibility, but SMI technique is more effective for targeting posterior chain flexibility.

DISCUSSION

Current study compared the effects of the Sub occipital Muscle Inhibition Technique and the Doming of Diaphragm Approach on computer workers' hamstring flexibility. This study entailed 120 individuals (60 in each group). Participants were randomly allocated into two separate groups, Group A comprised of 15 women and 45 men and Group B comprised of 13 women and 47 men. Both groups' age ranges from 35 to 55. Mean Age, Height and Weight in Group A is 41.88, 165.45 and 68.72 respectively and that in Group B is 43.15, 167.82 and 70.55 respectively. Group

A received Sub occipital muscle inhibition technique and Group B received Doming of Diaphragm approach. The Sub occipital Muscle Inhibition technique was administered for 4 minutes to the subjects in Group A. Applying the AKE test, SLR test, and MSRT, hamstring flexibility was analyzed pre- and post - intervention. According to the result, there is significant difference of -12.55 for AKE (R), -13.25 for AKE (L), -17.16 for SLR (R), -17.65 for SLR (L) and -4.55 for MSRT. Data therefore shows that the hamstring flexibility has been significantly increased by the sub occipital muscle inhibition technique .Localized stretching procedures to improve hamstring length may exacerbate the regional inflammatory reaction, increases muscle spasm, and cause increased guarding in individuals suffering from acute lower back pain. Pollard and Ward's study's recommended cervical spine approach may prevent pressuring or stressing vulnerable structures while enhancing hip flexion range of motion and hamstring elasticity. Their studies find out the remoteness of the site of treatment to the region of effect but there was lack of explanation for this effect. [18]The study of Neha Gupta et al[19], concluded that that neck flexors' my of as cial release approach is beneficial for increasing hamstring flexibility and provided justification for the SMI technique. Thus, results of this study correspond with other published studies on this matter highlighting the efficacy of SMI technique for enhancing hamstring extensibility. By using the SMI technique, hamstring flexibility was improved due to the fact that sub occipital muscles gets relaxed which in turn leads to the relaxation of the superficial backline. With "onion peel effect", the goal of SMI is to provide soft traction to feel the tension in the soft tissues and break down the muscle barrier by repeatedly straining and relaxing it. For fascia to relax effectively, proper pressure and soft extension should be applied on the area where fascia limitation is felt.

In the human body, the sub-occipital muscles comprises the maximum muscle spindles and are the proprioceptor monitors that play a vital role in governing head posture. It is interesting to note that, Pontell et al. reported that the sub-occipital muscles are associated to the cervical dura mater by a myodural bridge linkage. Based on this result, it is also plausible that the myodural bridge's diminished tension post the SMI technique may ease dural enfolding, subsequently lessening the initiation of the nociceptive pain mechanisms [5,6,] Hence, results reflects that by direct relaxation of the posterior neck region by utilizing the SMI technique is primarily responsible for increased stretching and a decrease in the tone of the myodural bridge and hamstring muscles. Subjects in Group B received 5 minutes of Doming of Diaphragm approach. According to the result, there is significant difference of -12.01 for AKE (R), -11.73 for AKE (L), -18.53 for SLR (R), -18.55 for SLR (L) and -3.08 for MSRT. So, this demonstrates that the DD approach has resulted in a noticeable positive impact on hamstring flexibility. Hamstrings mainly intervene in posture and mobility in the sagittal plane, either by limiting trunk flexion or, in case of dysfunction, exaggerating or maintaining excessive backward movement. Breathing is one of the finest methods for correcting pelvic tilt. From a conceptual standpoint, applying Diaphragm Doming would prompt engagement of core stabilizing muscles and restoration of abnormal motor control techniques used by people with tight hamstrings, thus increasing hamstring extensibility. Debora Fortes Marizeiro et al in his study concluded that sedentary women benefitted from diaphragmatic myofascial release therapy in terms of improved chest wall mobility, posterior chain muscle flexibility, and some lumbar spine motions [20].

Another study of Francisco J. Gonzalez-Alvarez et al has proven that diaphragmatic stretching substantially enhanced cervical extension, right and left cervical flexion, flexibility of the posterior chain, and ribcage excursion at the xiphoid level in healthy individuals.[21]. Findings of this study are thus congruent with those that other writers have previously documented. Given that muscles function synergistically together in a chain, it is likely that the doming of the diaphragm method can promote hamstring flexibility. This is because contractions of muscular chains can alter the ROM in different remote structures or muscles. It has been hypothesized that when a muscle shortens, both nearby and distant muscles compensate. The biomechanical association between the diaphragm and other tissues offers base to the idea that diaphragm doming can affect other remote structures. According to a current theory in the medical literature, the body will try to make up for inadequate core stability by increasing the tightness of the hamstrings. "Kuszewski et al" claim that the contrary might also be present. In his research, he hypothesized and defended that improved performance of core stability would result in increased flexibility of the hamstring musculature [22]. Thus, diaphragm being the roof of the core, doming of diaphragm can have effect on hamstring muscles' elasticity.Thus, results of current trial showed that, there is no significant statistical difference between two

groups for outcomes AKE and SLR, but for MSRT, p-value <0.05, thus by looking at mean differences of pre-post data, we can say that SMI technique was found superior to the DD approach for improving hamstring flexibility. By this, we can say that, with SMI technique, whole of the superficial back-line, covering that of the cervical, thoracic, lumbar, as well as lower extremities gets relaxed as a result, it showed greater improvement in MSRT, as the test procedure involves thoraco-lumbar as well as lumbo-pelvic motion.Thus, this study proves that SMI technique as well as DD approach is found to improve hamstring flexibility, but SMI technique was found superior to DD approach for targeting posterior chain flexibility.

CONCLUSION

This study concludes that significantly greater improvement was observed in Group A that received sub occipital muscle inhibition technique for MSRT than in Group B that received Doming of diaphragm approach. Both methods were found to be equally effective for AKE and SLR test. As a result, both methods are successful for increasing hamstring flexibility, however for targeting posterior chain flexibility, the sub occipital muscle inhibition technique was found to be superior to the doming of diaphragm.

CLINICAL IMPLICATION
According to literatures, diminished hamstring flexibility could be the source of low back pain (LBP). Interestingly, a hamstring muscle tension and shortening can induce neck and shoulder pain. Along with this, fascial restrictions could also lead to reduced range of motion across the joint. Also, reduced hamstring flexibility can alter the posture and increases the risk for injury. Nowadays, fascia release therapy is widely used approach to increase the muscle flexibility. Therefore, clinicians should take into consideration about the SMI technique for targeting postural chain flexibility as well as DD approach for improving my kinetic chain functions.

LIMITATIONS
1. Long term follow-up was not taken.
2. Control group was not taken.
3. Subjects were taken from only two companies.

FURTHER RECOMMENDATIONS
1. Study can be carried out in different population.
2. Long lasting effect can be checked.
3. More subjects can be taken for the study.
4. Different interventions can be compared.

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Table 1: Mean distribution of Age, Height and Weight in two Groups.

Variables	SMI		DD		
	Mean	SD	Mean	SD	P-VALUE
AGE	41.88	4.77	43.15	5.66	0.21
HEIGHT (Cms)	165.45	6.94	167.82	6.88	0.05
WEIGHT (Kgs)	68.72	6.95	70.55	3.89	0.61

Table 2 : Within Groups Comparison in Group A and Group B

OutcomesMeasures	SMI			DD		
	Mean	SD	P-VALUE	Mean	SD	P-VALUE
PRE AKE (RIGHT)°	117.27	2.79	P< 0.001	118.02	2.66	P< 0.001
POST AKE(RIGHT)°	129.82	2.95		130.03	2.91	
PRE AKE (LEFT)°	118.2	2.38	P< 0.001	118.55	2.05	P< 0.001
POST AKE (LEFT)°	131.45	2.84		130.97	2.52	
PRE SLR (RIGHT)°	66.82	2.44	P< 0.001	66.55	2.79	P< 0.001
POST SLR (RIGHT)°	83.98	2.78		85.08	3.08	
PRE SLR (LEFT)°	67.58	2.28	P< 0.001	67.3	2.45	P< 0.001
POST SLR (LEFT)°	85.23	2.72		85.02	2.7	
PRE MSRT (cms)	22.55	2.47	P< 0.001	22.82	1.95	P< 0.001
POST MSRT (cms)	27.1	2.27		25.9	1.93	

Table 3: Between Group Comparisons of means of differences of pre-post values in both groups

OutcomesMeasures (Pre-Post mean differences)	SMI		DD		
	Mean	SD	Mean	SD	P-VALUE
AKE (RIGHT)°	12.55	2.51	12.02	2.27	0.333
AKE (LEFT)°	12.25	2.24	11.73	2.48	0.267
SLR (RIGHT)°	17.17	2.04	18.53	3.53	0.198
SLR (LEFT)°	17.65	2.14	18.55	3.37	0.066
MSRT (cms)	4.55	1.11	3.08	0.62	0.000

| Figure 1 | Figure 2 | Figure 3 |

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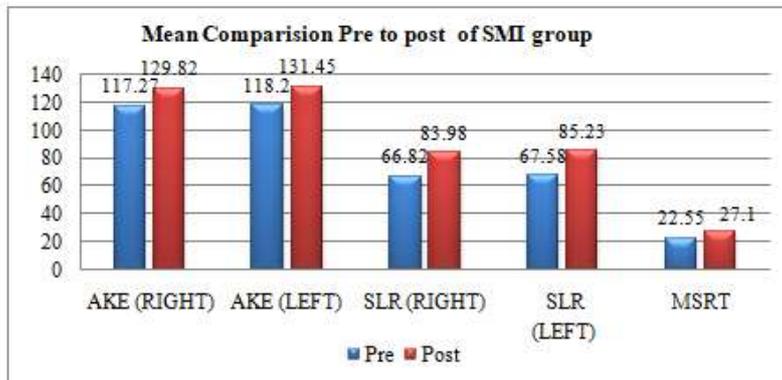
Graph 1. **Mean Comparision Pre to post of SMI group**
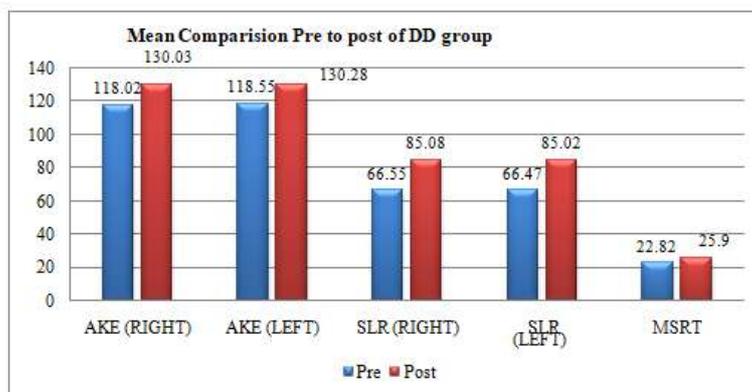
Graph 2. Mean Comparision Pre to post of DD group
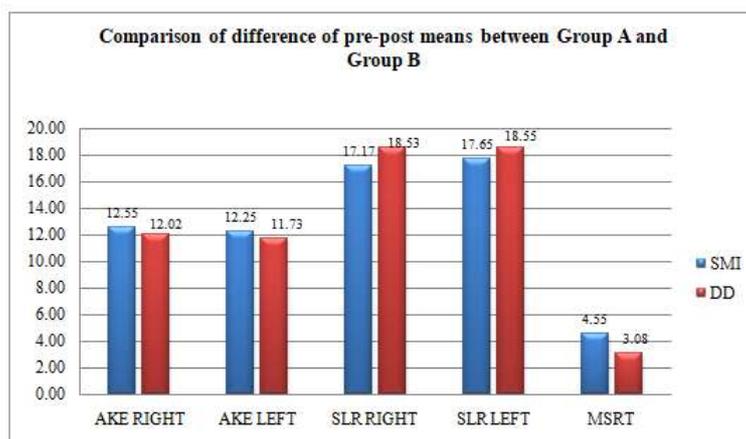
Graph 3. Comparison of difference of pre-post means between Group A and Group B

RESEARCH ARTICLE

Efficacy of Simple Exercises on Fear of fall among Elderly Population

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ABSTRACT

Fear of fall (FOF) is a serious problem since it impairs physical function and increases the prospect of falls among older people. There were a few interventions that have been demonstrated to reduce fear of falling, with multi factorial approaches. However, older persons may not always be able to use or prefer multi factorial programs. Hence, this study is intended to analyze the fear of fall, by providing simple exercises, among elderly population. To analyze the efficacy of simple exercises on fear of fall, among elderly population. The subjects who satisfied the inclusion criteria and those who willing to participate were recruited for the study an informed consent was obtained from all the participants. 36 samples were collected. The demographic data were obtained and the FES (Fall Efficacy Scale) was explained clearly, then the individual scoring was done and documented. Subjects who scored≥ 20 on FES were selected and simple exercises were given. This exercise session was given for 2weeks, (3 days/week). After 2 weeks exercises session, Patients were reassessed and scored with FES, the results were noted and statistically analysed. Paired t-test was done to analyse the difference between pre-test FES and post-test FES. There was a significant difference between pre-test FES and post-test FES, among elderly population by the supervised simple exercises. Thus, the study concluded that, the supervised simple exercises along with motivation had influence and showed a significant reduction in FOF, among elderly population.

Keywords: Aged, Exercise, Fear of falling, Physical fitness

INTRODUCTION

Older people frequently have fall anxiety and experience fear of falling (FOF), which has major physical and psychological impacts.[1]Fall-related consequences can be severe enough leading to long-term impairment and a significant decline in their quality of life.[2]Fear of fall can lead to limitations on or avoidance of everyday tasks, loss

of independence, a decline in social interaction, depression which may lead to deterioration in quality of life. [3] Among older persons, a higher prevalence of comorbidities, a lack of physical exercise, poor performance in everyday activities, and mobility restrictions have all been identified as predictors of fear of falling [3] . Fear of falling issue has been a big concern for older adults, their families, and healthcare professionals as well, given that it can increase the need for medical services. The clinical, psychological, social, and epidemiological ramifications of the fear of falling should be given special consideration since they have a significant impact on the older adult's health, wellbeing, and quality of life (QoL). [4] Even though fear of fall is a psychological state which indirectly leads to physical weakness and reduced mobility, one of the most effective methods for reducing the fear of fall among older people has been demonstrated to be exercise. [5]Exercise has been shown to be a successful method for reducing elderly people's fear of falling and actual falls. [6] Engaging in physical activity as a fall prevention technique lowers participant's fear of falling following the intervention. The combined effects of supervised simple exercises were found to reduce Fear of Fall and improve balance, reduce their risk of falling, increase their independence, and thereby promote their community participation. [6] In our study we therefore tried to incorporate a set of simple exercises under supervision for the individuals with the fear of fall. It is advised to start physical activity programmes for the elderly in a secure setting will build up sufficient self-confidence level to reduce fear of fall significantly. The primary purpose of this study was to evaluate the effects of simple exercise intervention on fear of fall among elderly population also to identify the perceived self-confidence following exercises which might improve physical health and reduce fear of fall.

MATERIALS AND METHODS

An interventional study was conducted in Physiotherapy out-patient department for the period of 3 months. Sample size was calculated using G-power software, and the total sample size estimated was 36. The Older adults those who can walk independently without using any assistive device in the age group of (aged ≥ 60 to 95 years), and those who score ≥ 20 on Fall Efficacy Scale- International Questionnaire were included in this study. And those with a history of visual and auditory impairments, dizziness, vestibular, neurological, orthopaedic, cardio-respiratory, psychological, uncontrollable systemic disease, severe musculoskeletal conditions requiring active management and the subjects receiving palliative care were excluded from this study. The Institutional Ethics Committee at Sri Rama chandra Institute of Higher Education and Research granted its approval on this study (CSP/23/FEB/122/107). The study was conducted among patients who attended Physiotherapy Outpatient Department at Sri Rama chandra Hospital. The subjects who satisfied the inclusion criteria and those were willing to participate were recruited for the study an informed consent was obtained from all the participants. 36 samples were collected. The demographic data were obtained by the therapist and the fall efficacy scale- international questionnaire was explained clearly, then the individual scoring was done and documented before the exercises. Subjects who scored≥ 20 on Fall Efficacy Scale-International Questionnaire were considered for the study and the following exercises were given. This exercise session was given for 2weeks, (3 days/week).

Figure 1. Seated Alternate Weight Shifts
Patients is asked to sit on a chair, slowly lean the body to the right, while keeping both the feet in contact with the floor, Repeat in other direction (10 repetitions each)

Figure 2. Seated Calf Raise
Patient is asked to sit on the chair, slowly raise both the heels off from the ground, while keeping all the toes in contact with the floor. (10 repetitions each)

Figure 3.Seated Toe Raise
Patient is asked to sit on the chair, slowly raise all the toes from the ground, while keeping the heels in contact with the floor (10 repetitions)

Figure 4. Seated Knee Flexion and Extension
Patient is asked to sit on the chair, slowly lift the right knee and bend down, repeat in other side (10 repetitions)

Figure 5. Heel Raise with Support
 Patient is asked to stand upright with knees straight, slowly raise both heels until weight is on balls of the feet, while holding on to the back of a straight chair. (10 repetitions)After 2 weeks exercises session, Patients were reassessed and scored with fall efficacy scale –international questionnaire, the results were noted and statistically analysed.

RESULTS

The collected data were analyzed using SPSS statistics software 23.0 version Normality test was analyzed using Shapiro-wilk test . For analysing Pretest FES and Post-test FES, paired t-test was used.

Table-1. Demographic data

Table-2. Statistically significant difference showed on post-test fes on mean and standard deviation.

Table-3. The above results shows that there was a statistically significant difference between pre and post-test fes, among elderly population. (p value <.001)

DISCUSSION

The present study investigated the efficacy of simple exercises on fear of fall, among elderly population. Although, this study is robust in supporting that physical exercise itself is an effective strategy to reduce fear of fall. Another factor associated with fear of falling was age. We found that senior adults (70 years or older) were more fearful of falling than younger older adults (60-69 years). Previous study done by Vitorino L et al, showed that the factors associated with fear of falling were, poor health and age, especially for those above 70 year. [5] All the exercises were done under supervision for 2 weeks (3 days/week) in order to build their self-confidence and avoid flaws during exercises. The idea of supervised exercises is to improve confidence level along with the mobility and strength of the lower limbs. There were also some evidences which is in line with our study by Saija Karin anta et al., who says that the effect of exercise interventions on fear of falling showed moderate level of reduction in fear of fall. [7] In this study, we found that there is a significant reduction on fear of fall, among elderly population. Even though exercises programs mainly aimed at improving physical fitness this has found to influence the self-confidence of the elderly who participated in the exercises sessions which had increased the motivation and reduced the fear of fall. Previous study done by Christain Erik et al., showed evidence that older adults with more engagement in physical activity had reduced fear of falling. [8] Our study found out that effect of exercise interventions had reduced fear of falling among elderly population even though the reduction was not very significant among very older individuals due to age related complications, this study has proved that a proper intervention along with motivation and supervision would create a change and reduce the fear and improve the mobility.

LIMITATIONS
Psychological component was not assessed.

CONCLUSION

Thus, the study concluded that, the supervised simple exercises had influence and showed a significant reduction in

fear of fall, among elder population. Hence, this supervised simple exercises can be recommended clinically for the elderly population, and easier to perform which can also improve their level of confidence in a considerable way.

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Table-1. Tests of Normality
Shapiro-Wilk

	STATISTIC	DF	SIG
SEX	.638	36	<0.01
AGE	.953	36	.131
PRETEST FES	.949	36	.097

Table-2 Paired Sample Statistics

VARIABLES	N	MEAN	STD. DEVIATION
PRETEST-FES	36	27.19	2.095
POSTTEST-FES	36	25.44	1.812

Table-3 Paired Sample Test

PRETEST(FES) -	PAIRED DIFFERENCES			SIGNIFICANCE	
	MEAN	STD.DEVIATION	T	ONE-SIDED P	TWO-SIDED P
POSTTEST(FES)	1.750	2.116	4.962	<.001	<.001

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Figure-1: Seated Alternate Weight Shifts

Figure-2:Seated Calf Raise

Figure- 3: Seated Toe Raise

Figure-4 Seated Knee Flexion And Extension

Figure-5 Heel Raise with Support

RESEARCH ARTICLE

Application of Machine Intelligence in Educational Sector

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ABSTRACT

Machine Intelligence is a mapping of human intelligence into artificial intelligence by which decisions may be performed by machines even better than human beings in complex situations. In the present scenario, the use of Machine Intelligence in educational sectors is a very demanding research area through which many problems related to student performance may be solved by extracting useful information from the fast-growing educational data. These studies can decrease the failure rate by providing well-timed counseling and advice to needy students and also may be pretty useful to fill the vacant seats by predicting good-performing students or providing suitable marks in the circumstances of pandemics. In the educational field, machine intelligence is implemented by applying various machine learning models to the students' data. In the present paper, the application of various state-of-the-art machine learning models such as Decision Tree, Naïve Bayes, k-Nearest Neighbor, Support Vector Machine, and Random Forest has been implemented in context to the educational data, and by applying these predictive models, it may be concluded that all the models used in the present study were capable to predict students' academic performance with more than 83% accuracy and Naïve Bayes has achieved highest accuracy of 89.61%.

Keywords: Machine Learning Models, Predictive Modeling, Educational Data Mining, Students' Academic Performance, Prediction.

INTRODUCTION

Education is the strongest weapon that has the ability to change society by impacting the growth of the nation and subsequently the growth of the whole world. So the main duties of every educational organization should be to provide quality education to every student and to identify weak learners at an early stage so that they can be counseled by their teachers or administration timely. Due to digitization and online practices in the education sector, the vast amount of educational data is available in electronic form but timely extraction of valuable information from this data is a very challenging task. In today's scenario, a very popular field named Machine intelligence is used to make important decisions by extracting useful information from a large amount of data with the help of machine learning models such as Decision Tree, Naive Bayes, Bayesian Network (Bayes Net), k-Nearest Neighbors (k-NN), Support Vector Machine (SVM), Artificial Neural Network (ANN), etc. Machine learning models are mathematical structures that are trained by training datasets and then are used to identify the required information. When machine learning models are applied to educational data, students' academic performance may be predicted so that the failure rate can be decreased by providing timely feedback and support to poor performers. With the help of machine intelligence, students' academic performance such as their grades or marks could be predicted on the basis of different attributes like their background, past academic performance, etc. So the implementation of machine learning models on educational data would be very beneficial to students as well as educators, as students may get their feedback from time to time to improve their shortcomings and educators could reduce the failure rate of students. The main goal of this paper is to develop a methodology to identify good and poor performers and to accomplish this purpose; the following steps have been performed

1. Apply five different classification techniques viz. Decision tree, Random Forest, Naïve Bayes, k-NN, and SVM on the Students' dataset and analyze the performance of all the five machine learning techniques in predicting students' performance at the time of starting the course.
2. Compare all five classification techniques on the basis of three performance metrics namely "accuracy", "recall" and "precision".

Although in the past, most of the authors predicted the performance of students during the course; the novelty of this paper is that the prediction task was performed at the time of starting the course. Thus, weak learners could be identified at an early stage and could be counseled by their teachers as soon as possible. The organization of this paper is as follows. In section 2, a brief survey of machine learning models used in educational data has been presented. The methodology to apply machine learning models to educational data is given in section 3. In section 4, experimental results that compare different machine learning strategies on educational datasets in terms of classification accuracy, precision, and recall are elaborated. Finally, the conclusion and future works are mentioned in section 5.

Related work

Machine intelligence has been implemented in educational areas for extracting useful information from educational datasets and to make the right decisions timely when dealing with educational problems. There are various supervised machine learning techniques such as classification (Decision Tree, Naïve Bayes, Bayes Net, SVM, ANN, Random Forest, etc.) and regression; and unsupervised machine learning techniques such as clustering (k-mean, DBSCAN, etc.) and association rule mining (Apriori Algortihm), which may be applied on educational data. Acharaya and Sinha (2014) applied classification algorithms namely Decision Tree, SVM, ANN, and Bayes Net on students' datasets to forecast the students' academic performance at an early stage. In their study, they identified that Decision Tree and SVM outperformed all the other classifiers [1]. Another research conducted by Tripti et al. (2014) implemented two classification techniques namely Random Tree and J48 on the academic data of MCA students' and observed Random Tree to be outperformed in comparison to J48 [2]. Further, Binh and Duy (2017) pointed out that due to the diverse personalities various students have different manners of learning and that impact the outcome of students' results. On the basis of the manner of learning, they predicted students' academic performance by

implementing ANN algorithm for the prediction [3]. Ha et al. (2020) used PART, OneR, Random Tree, Random Forest, J48, Naive Bayes, SVM, and MLP to predict the final marks of students by using the background and academic data as attributes and concluded that Naïve Bayes and MLP outperformed other algorithms with prediction accuracy of 86.19% [4]. Atlam et al. (2022) applied Logistic Regression, Random Forest, AdaBoost, Extreme Gradient Boosting, Support Vector Machine, and Decision Tree to analyze the impact of COVID-19 on the psychological health of students [5]. Pande (2023) predicted the performance of students with the help of various machine learning models, including k-NN, SVM, and Logistic Regression. They found that the SVM classifier with a linear kernel achieved the highest accuracy of 84.37% [6]. Ensemble classifiers are also very popular in the educational sector for the prediction of students' academic performance. These classifiers are made up of many single classifiers for increasing the accuracy of the prediction task [7]. There are various examples of ensemble classifiers such as Random Forest, Voting Classifier, Adaptive Boosting, Gradient Boosting Machine, Stacking Classifier, Extreme Gradient Boosting, etc. Pandey and Taruna (2014) compared four different types of ensemble techniques namely Bagging, Boosting, Random Forest, and Adaboost for predicting the student's academic performance, and found that Random Forest was the best ensemble classifier [8]. The same team consisting of Pandey and Taruna (2016) has implemented an ensemble model by integrating three different classifiers viz., Decision tree, Aggregating One-Dependence Estimators, and k-NN and applied this ensemble classifier to engineering students' data for forecasting their future performance. In their research, they found that the proposed model outperformed other models [9]. Ashraf et al. (2018) performed an investigation to predict student performance by using a pedagogical dataset and applied an ensemble classifier namely Stacking C to that dataset.

In their research, they achieved 95.65% accuracy with Stacking C and concluded that data balancing procedures namely under sampling (spread sub-sampling) and oversampling (SMOTE) increased accuracy to 95.96 % and 96.11% respectively [10]. Kumari et al. (2018) have applied three ensemble techniques viz. Voting, Bagging, and Boosting, through which they achieved the best result in comparison to single classifiers and also proved the reliability of the proposed model [11]. Injadat et al. (2020) have used an ensemble learner from a combination of six potential machine learning algorithms for predicting students' academic performance [12]. Asselman et al. (2021) have implemented several integrated classifiers for improving the forecasting rate and concluded that XGBoost has the maximum efficiency to identify low performers [13]. Yagci (2022) evaluated SVM, Random Forest, Naïve Bayes, k-NN, and Logistic Regression for forecasting the end-year marks when applied to a dataset of 1854 students with academic attributes. They concluded Random Forest gave the highest prediction accuracy of 74.6% [14]. Goundar et al. (2022) implemented several classification algorithms to construct a prediction model that determines the academic performance of students. They found that Random Forest performed better than other algorithms [15]. The regression technique is a numeric value prediction data mining technique used to find out the relationship between dependent variables and one or more independent variables, as well as to determine how such a relationship can be used to predict students' academic achievements. Husain et al. (2021) performed regression analysis of student academic performance using deep learning [16]. Unsupervised machine learning techniques such as clustering and association rule mining are other popular methods in the educational sector. Clustering is used to identify groups of students who have similarities in learning Govindasamy and Velmurugan (2018) conducted research in which they compared four different types of clustering namely k-Medoids, k-Means, Fuzzy C-Means, and Expectation Maximization for evaluating students' academic performance. They observed that Fuzzy C-Means and Expectation Maximization performed better than the other two [17]. Goh et al. (2020) implemented k-means clustering with a deterministic model to analyze the student's academic performance [18]. Association rule mining is a machine learning technique used to find out rules that will predict the occurrence of an item based on the occurrences of other items. Hussain et al. (2018) implemented Apriori algorithm to find the association rule mining among all the students' attributes and displayed the important rules [19].

From past studies, it may be concluded that different types of supervised and unsupervised machine learning models are very beneficial in educational sectors for predicting the academic outcome of students so that poor performers may get timely support from their administration or faculties and good performers may get placed in any reputed organization or may help to low performers also. It may also be observed from the past literature, that a

particular machine learning algorithm is not suitable for all the datasets. The accuracy of any machine learning model depends on the features of the students' dataset. Past studies have focused on identifying the student's academic performance by using different categories of features that were related to students' background, past academic performance, social, psychological, and behavioral characteristics. So, before applying any machine learning model, the identification of necessary features is a very important step for predicting students' future outcomes efficiently.

METHODOLOGY

In this section, we discuss how any machine learning model could be implemented on any educational data for estimating good and poor performers. To perform any machine learning task easily and efficiently, firstly data is pre-processed so that all the noise, duplicity, and unrelated features may be removed. After pre-processing, data is ready for application in any machine learning model. The schematic of the methodology is given in Fig. 1.

Dataset Selection
There are two types of data i.e. primary or secondary. Primary data is newly created and secondary data is already available. Primary data can be collected through questionnaires, interviews, observation, schedules, etc. The questionnaire is the most popular method for collecting primary data. So, in this study, data is collected from students of different branches of Bipin Tripathi Kumaon Institute of Technology, Dwarahat (Almora), India through the questionnaire that was filled out by participants through online mode. The dataset which is a type of primary data, consisting of 383 records containing background, academic, psychological, and social features were used to predict students' academic outcome and to find out the best machine-learning strategy. All the attributes in a dataset are categorical. The basic attributes of the investigated educational datasets are given in Table 1. From the above table, it is shown that there are different categories of students' features in which the target variable is 'first-semester grade' having two different values 'A' and 'B'. The student having Grade A denotes 'good performer' and the student having Grade B denotes 'poor performer'. The goal of the present study is to identify good performers and poor performers with the help of machine learning models by which machine intelligence denotes a significant role in the educational sector.

Data pre-processing
In this step, feature selection, balancing the dataset, handling missing values, and data transformation may be performed according to the characteristics of a dataset. By feature selection techniques, only relevant and influential features are selected automatically or manually. Further, there are various machine learning techniques that do not support missing values, so the handling of missing values is also important. Moreover, if a dataset has a high difference between positive classes and negative classes, then an imbalanced dataset has to be converted into a balanced dataset by the various types of re-sampling techniques such as oversampling, undersampling, and hybrid sampling. Furthermore, data transformation is also very necessary for converting data into a format that is suitable for machine-learning models by various types of encoding schemes. In the present work, the examined dataset was balanced, low dimensional, and did not contain any missing values. So, only data transformation was required to preprocess the data that was done with the help of Label Encoder of sklearn. preprocessing module of Python programming language.

Apply machine learning model
In the present work, five different machine learning models were created viz. Decision Tree [20], Naïve Bayes [21], k-NN, SVM [22], and Random Forest model [23] were applied to the examined "labeled" dataset of students and their results were compared. For the model validation, the hold-out method was used in which 80% of the dataset was reserved for the training purpose and 20% of the dataset was reserved for the testing purpose. In the dataset, the total number of records is 383, among them, 306 records were used for training and 77 records were used for testing. In the testing dataset, 43 records were for class 'A', and 34 records were for class 'B'. For the equal class distribution

in the training set as in the original dataset, stratified sampling was used. All the passing parameters for the machine learning techniques were set with the help of the Grid Search CV algorithm, so that better results may be achieved.

Result evaluation and comparison

The performance of any machine learning model could be evaluated and compared in terms of precision, recall, accuracy, f1-score, etc. are computed with the help of a popular tool called "confusion matrix" [24]. In our study, binary classification is done as our aim to find out low-performing students so a 2 x 2 confusion matrix is used that consists of four different values viz. True Positive, False Positive, False Negative, and True Negative. From the confusion matrix, a performance metric "classification accuracy" of the model can be calculated. Because of the fact that only accuracy is not sufficient to conclude whether a classifier significantly predicts low performers and good performers, other performance metrics "recall" and "precision" for low performers and good performers were also calculated for each classifier.

RESULTS

In the present study, to find out students' academic performance five supervised machine learning models viz. Decision Tree, Naïve Bayes, k-NN, SVM, and Random Forest were implemented on the students' dataset. The implementation was done by using Python's open-source machine learning library 'sklearn'.

Machine learning strategies

In this paper, all of the five machine learning models and their passing parameters that were set by Grid Search CV are listed in Table 2.

Decision Tree

In this work, CART (Classification & Regression Tree) was implemented that uses "Gini" as attribute selection criteria by restricting the tree's height up to 3. When Decision Tree was applied to the students' dataset, 83.11% accuracy was achieved with the following confusion matrix: From Table 3, it is shown that Decision Tree truly identifies 39 good performers out of actual 43 good performers, and 25 low- performers out of actual 34 low performers, this means that recall values for Class A and Class B are 91% and 74% respectively. Further, Decision Tree predicts 48 students as good performers, but among them, only 39 students are truly identified, so precision for class A is 81%, similarly precision for class B is 86%.

Naive Bayes

After implementing Gaussian Naive Bayes on the dataset, the results are presented in Table 4. Table 4 presents that Naive Bayes classifier correctly classifies about 89.61%. Further, recall for identifying good performers and low performers are 91% and 88.23% respectively. Moreover, precision for good performers and low performers are also 91% and 88% respectively. All three metrics viz. accuracy, precision, and recall for Naïve Bayes are better than the Decision tree.

k-Nearest Neighbors (k-NN)

In the present work, the value of k was set to 19. The result of k-NN is given in Table 5. From the confusion matrix, it was found that k-NN has achieved 84.42% accuracy. Table 5 represents k-NN identifies good performers efficiently as its recall for class A is 95% but recall is low (71%) for class B i.e. it could not identify low performers efficiently. Further, Precision for good performers and low performers are 80% and 92% respectively. In comparison to others, k-NN has the highest precision for class B.

Support Vector Machine (SVM)

When SVM with "rbf" kernel was implemented on the data set then 85.71% accuracy was achieved. The result of this algorithm is given in Table 6. From Table 6, it is concluded that SVM can truly identify 39 good performers out of 43

and can also identify 27 low-performers out of 34. So, the recall for class A and class B are 91% and 79% respectively. Moreover, precisions for Class A and Class B are 85% and 87% respectively.

Random Forest
After implementing Random Forest with 7 estimators on the students' dataset, 85.71% accuracy was achieved which is the same as SVM and its confusion matrix is also the same as Table 6 of SVM.

Comparison of different machine learning strategies
In this section, the comparison of all five machine learning models is described. The comparison of different classifiers in terms of their accuracy, precision, and recall for class A and class B are described in Table 7. From Table 7, it is observed Naïve Bayes has the highest classification accuracy, highest precision for class A, and highest recall for class B. Recall for class A and precision for class B are also high. So, it is concluded that the overall performance of Naïve Bayes is higher than other models. For better understanding, a graphical representation of the above results is shown in Fig. 2, Fig. 3, and Fig. 4. Fig. 2 represents the comparison of different classifiers in terms of accuracy, Fig. 3 represents precision and recall for class A of different classifiers, and Fig. 4 represents precision and recall for class B of different classifiers. From Fig. 2, it is concluded that accuracy is highest for Naive Bayes. Hence, Naïve Bayes outperformed other classifiers. All the machine learning algorithms have accuracies greater than 80%, it is concluded that all the machine learning algorithms are able to predict students' academic performance at an early stage. Further, Fig. 3 and Fig. 4 represent the comparison among different machine learning models in terms of precision and recall for identifying good performers and low performers respectively. From both figures, it is concluded that Naïve Bayes has achieved high precision and high recall for both classes in comparison to any other classifiers. Overall, in the present study, it is concluded that Naive Bayes achieved the highest accuracy with high precision and high recall values for class A and Class B both.

CONCLUSION AND FUTURE WORK

The present work focuses on the application of machine intelligence in the educational sector. The success of any educational organization depends upon the success of its students so the primary goal of the present study is the identification of weak students at an early so that they could get timely support from their teachers. To achieve this goal, five different supervised machine learning techniques viz. Decision Tree, k-NN, SVM, Random Forest, and Naïve Bayes were applied to the students' dataset for classifying students as low-performers or good-performers. It was observed that all five algorithms can predict student performance at an early stage with more than 80% accuracy. After that, the performance of all the classification techniques is evaluated and compared. From this study, it was concluded that Naïve Bayes achieved maximum accuracy (89.61%) and also achieved the highest recall (88.23%) for predicting poor performers. The present study implies that machine-learning models are helpful in the academic field. With the help of these models, decision-makers can make a plan for the institution's strategy and policy effectively [25] as well as allocate limited resources efficiently [26]. Besides this, managers could predict academic failure and could act accordingly such as taking extra classes, providing training for improvement in study skills, etc. [27]. Moreover, machine learning models could be used to identify good performers who increase the reputation of any organization. Such students could help low-performing peers in their studies. This study has some limitations. One of them is the size of the dataset was limited to only 383 students of only one institute hence it is sample-biased, the results are valid for this sample only, this limitation may be resolved by increasing the size of the dataset and including data of more institutes of different region. Another limitation of this study is related to the education field. In this paper, only engineering students are considered but this study could be implemented for other educational fields like art, science, and management too. An additional limitation of this study is related to feature selection. In this work, all the input features were selected. So in the future, these limitations may be resolved by using feature-selection techniques so that better prediction accuracy can be achieved. Further, any other types of machine learning strategies like clustering or any other ensemble machine learning may be used for improving the results.

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Table 1: Main features of students' dataset

Attribute	Type	Attribute	Type
Sex	Nominal	Percentage of 10th standard	Ordinal
Category	Nominal	Percentage of 12th standard	Ordinal
Number of brothers and sisters	Ordinal	Rank in Entrance exam	Ordinal
Parents' status	Nominal	Average Self-Study Time	Ordinal
Father's education	Ordinal	Extra-Curricular Activities Participation	Nominal
Mother's education	Ordinal	Have good friends	Nominal
Father's job	Nominal	Motivation	Ordinal
Mother's job	Nominal	Health Status	Ordinal
Family status	Ordinal	Homesickness	Ordinal
Residential location	Nominal	First Semester Grade (Target feature)	Ordinal
Medium of previous study	Nominal		

Table 2: Machine learning models along with their passing parameters.

Machine learning models	Parameters' setting	Machine learning models	Parameters' setting
Decision Tree	criterion="gini", max_depth=3, max_leaf_nodes=8	SVM	C=1, kernel='rbf'
Naïve Bayes	No parameters	Random Forest	n_estimators=7
k-NN	n_neighbors=19		

Table 3: Confusion matrix for decision tree

Actual/Predicted	A	B	Recall
A	39	4	91%
B	9	25	74%
Precision	81%	86%	

Table 4: Confusion matrix for Naïve Bayes

Actual/Predicted	A	B	Recall
A	39	4	91%
B	4	30	88%
Precision	91%	88%	

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Table 5: Confusion matrix for k-NN

Actual/Predicted	A	B	Recall
A	41	2	95%
B	10	24	71%
Precision	80%	92%	

Table 6: Confusion matrix for SVM

Actual/Predicted	A	B	Recall
A	39	4	91%
B	7	27	79%
Precision	85%	87%	

Table 7: Results of various classifiers

Classifier	Accuracy	Precision (for class A)	Recall (for class A)	Precision (for class B)	Recall (for class B)
Decision Tree	83.11	81	91	86	74
Naïve Bayes	89.61	91	91	88	88
k-NN	84.42	80	95	92	71
SVM	85.71	85	91	87	79
Random Forest	85.71	85	91	87	79
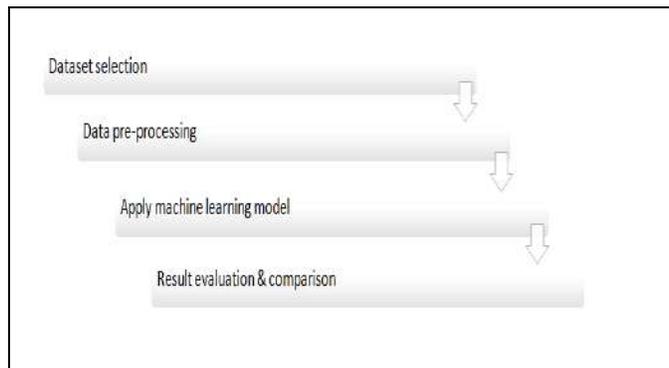
Fig 1: Diagram of the Methodology
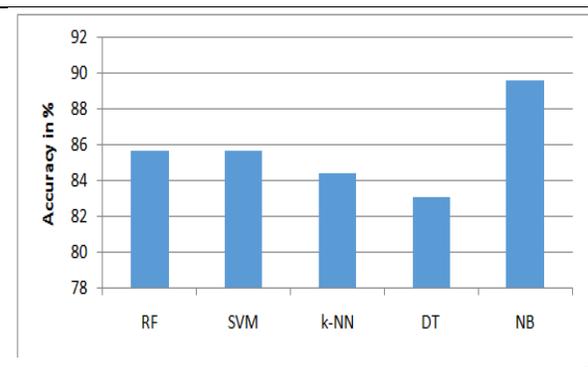
Fig 2: Comparison of different classifiers in terms of accuracy
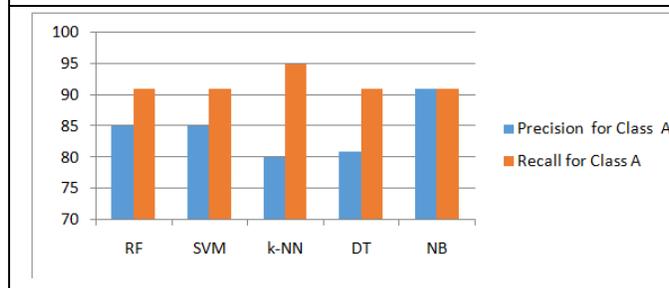
Fig 3: Results for Class A
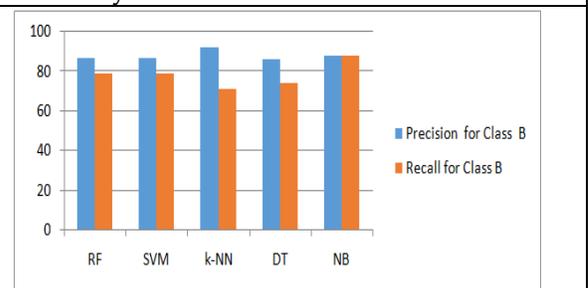
Fig 4: Results for Class B

RESEARCH ARTICLE

Exploring the Potential of Individualized Homoeopathic Treatment in Reducing Bronchodilator Dependency: A Case Study of Pediatric Asthma

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ABSTRACT

Asthma is one of the most common chronic conditions among children, impacting an estimated 7.5% of children and adolescents under 18 years of age worldwide. Conventional treatments often involve the use of bronchodilators and corticosteroids, which may provide temporary relief but fail to address the underlying causes. This case presentation explores the successful treatment of a pediatric patient with asthma using individualized homoeopathy. 7years old girl came with complaints of recurrent symptoms of breathlessness, coughing and wheezing. She is currently using short acting bronchodilators since last 10 days. After careful case taking considering her physical and mental symptoms and repertorisation, Bryonia alba 30 was prescribed. Her initial Asthma control Questionnaire (ACQ) score was 28. On subsequent follow ups Using the Asthma Control Questionnaire (ACQ) as an outcome measure, the case tracked symptomatic improvement and no bronchodilator usage over time. The case study indicates the potential effectiveness of homoeopathic medicine as a complementary approach in pediatric asthma management, warranting further investigation in controlled clinical studies.

Keywords: Pediatric Asthma; Individualized Homoeopathy; Bronchodilators; Asthma Control Questionnaire.

INTRODUCTION

Asthma is one of the most common chronic conditions among children, impacting an estimated 7.5% of children and adolescents under 18 years of age worldwide [1]. These patients frequently experience recurrent episodes of wheezing, coughing, shortness of breath, and chest tightness, which can lead to substantial impairments in their quality of life [2]. The standard care of pediatric asthma primarily involves the use of bronchodilators and corticosteroids [3]. However, these medications can pose potential side effects and may not fully control the symptoms or progression of the disease [4]. Consequently, many parents and caregivers are seeking alternative or complementary treatments, such as homoeopathy[5]. Homoeopathy, is system of medicine developed in the late 18th century, based on the principle of "like cures like" [6].Individualized homoeopathic treatment, a unique approach within homoeopathy, involves individualized remedies to each patient based on their specific symptoms and overall health status [7].

MATERIAL AND METHODS

In this case study, a patient of pediatric age group from Sainath Hospital OPD of Ahmedabad Homoeopathic Medical College, Parul University, Gujarat is presented which shows how the chronic respiratory ailments were managed with Homoeopathic medicines. Homoeopathic Case taking and Record-keeping format is followed. Asthma control Questionnaire (ACQ) Scoreis used to assess the effectiveness and outcome of treatment. It is simple questionnaire to measure the adequacy of asthma control and change in asthma control which occurs either spontaneously or as a result of treatment. ACQ was developed and validated by Prof. Elizabeth F. Juniper, MCSP, MSc. (8)Initial score was 28; the score was taken on every subsequent follow-up to assess the outcome of the treatment. (Table 1)

Case Report
Case Study
A7years old girl came with her parents at Sainath Hospital OPD of Ahmedabad Homoeopathic Medical College, Parul University, with chief complaint of recurrent episodes of coughing, wheezing, and shortness of breath since the age of 4. The symptoms were particularly exacerbated during seasonal changes, during damp weather and exposure to dust and strong smell. The episodes were accompanied by chest tightness and frequent nocturnal awakening due to breathing difficulties. Child's parents reported various incidences of hospitalizations for asthma exacerbations in the past 2 years. At the time of consultation, she was on inhalation of quick acting bronchodilators2 to 3 times a day for the past 4 months, but with temporary relief only. Frequency of these inhalations had increased in the last 2 weeks. Parents sought an alternative treatment approach due to concerns about the long-term use of bronchodilators and the desire for a more holistic and individualized approach.

Medical History
The patient had a history of recurrent attacks of coughing, wheezing and breathlessness, while consulted with a physician Bronchial Asthma was diagnosed 3 years ago. Medical history and follow-up revealed that the patient was treated with Modern medicines, but there was no relief in symptoms. Her mother had Bronchial asthma during childhood. Patient was fair complexioned and lean and thin. She had light colored hairs which seems dry and rough. She is little bit ill tempered, very stubborn and shouts and cries loudly if refused some demand. Parents reported that they are vegetarian and her appetite is good. She likes sweets very much, and drinks lots of water daily and perspires profusely, especially on head, face, and neck. Parents said that she is highly active and extrovert. She always wants to play and likes to have someone with her all the time. Her concentration is poor and she is not much interested in studies. Depending on the constitution, modalities, and pathological symptoms and on the knowledge of Homoeopathic Materia Medica, *Bryonia alba* was prescribed in 30CH potency, in a single dose with *Placebo* in 40

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size globules every 2 hourly for 3 days (Table 1 & 2; Fig. 1). Parents were advised to continue bronchodilator inhalation if condition demands.

Selection of Remedy

The case was repertorised using Synergy Homoeopathic Software with reliable repertory[9], to find the similar group of remedies, after analysis and evaluation of symptoms. Following symptoms were taken for the repertorisation to get group of remedies which are very similar to the patient's overall constitution.

Obstinate	*Difficult concentration*
Fear of being alone	*Playful*
Desire sweets	*Desire for company*
Profuse perspiration	*Anger in children*
Thirst for large quantities of water	*Contradiction-intolerant*

Repertorisation gives the result as shown in Figure 1. Following remedies were compared with the help of Homoeopathic Materia Medica for final selection of the remedy-

- *Lycopodium cla.*
- *Bryonia alb.*
- *Phosphorus*
- *Conium mac.*
- *Aconite nap.*
- *Hepar sulph.*

Bryonia was selected with the following considerations and symptom similarity on consulting Homoeopathic Materia Medica-

- Bryonia patients are irritable, ill-tempered which brings on complaints.[10,11]
- Ill effects of anger, fright. [12]
- Cough at night, must sit up [10]
- Thirst for large quantity of water
- Bryonia works nicely for difficult respiration, breathing quick, difficult, and anxious [13]
- Ailments from sudden change in weather, draft of air [10,11]

DISCUSSION

Bronchial Asthma is one of the most common chronic conditions among children, impacting an estimated 7.5% of children and adolescents under 18 years of age worldwide. The present study was primarily aimed to investigate the effectiveness of the individualized homoeopathic medicine in the management of cases of pediatric asthma. The selection of the remedy, Bryonia, was based on a thorough evaluation of the patient's symptoms, temperament, and overall health and backed by Repertorisation and Materia medica both. The treatment appeared to reduce the severity and frequency of asthma attacks, improve lung function, and reduce dependence on bronchodilators in this child, as evident from Asthma Control Questionnaire. Homoeopathy aims to stimulate the body's self-healing mechanisms by matching the patient's symptoms to a carefully chosen remedy. It offers a holistic approach to asthma management, addressing the underlying causes rather than suppressing symptoms.

CONCLUSION

The case study suggests that homoeopathy can be considered as an effective method for the treatment of pediatric asthma. It can be adopted as an alternative approach that could improve patient outcomes and reduce dependency on conventional medicines, i.e.; bronchodilators. A larger number of cases and controlled clinical trials can be carried out to further confirm the results.

ACKNOWLEDGEMENTS

Declaration of Patient Consent
The author certify that he had obtained all appropriate consent from the patient and along with her parents for investigation reports and other clinical information to be reported in the journal.

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Table 1:Asthma Control Questionnaire (ACQ) Scores.

SL. No.	Questionnaire	7.09.22	10.09.22	17.09.22	30.09.22	08.10.22	21.10.22
1	During the past 7 days, how often were you woken by your asthma during the night	5	4	3	3	1	0
2	During the past 7 days, how bad were your asthma symptoms when you woke up in the morning	4	2	2	3	1	0
3	During the past 7 days, how limited were you in your activities because of your asthma	4	3	2	2	2	1
4	During the past 7 days, how much shortness of breath did you experience because of your asthma?	5	2	2	2	1	1
5	During the past 7 days, how much of the time did you wheeze (have noisy breathing	5	3	3	3	2	2
6	During the past 7 days, how many puffs/inhalations of reliever medication	2	2	1	2	0	0
7	FEV_1% Predicted	3	2	1	1	1	1
	Total	**28**	**18**	**14**	**16**	**8**	**5**

Table 2: Follow-up data

SL. No.	Date	Symptoms	ACQ score	Prescription
1	10.09.22	Symptoms of cough and breathlessness are very much relieved. After 2 days of first prescription, she took bronchodilator only once in a day.	18	Placebo in 40 size globules thrice a day for 7 days.
2	17.09.22	Episode of night time aggravation reduced, wheezing reduced significantly, occasionally taken bronchodilator.	14	Placebo in 40 size globules thrice a day for 15 days.
3	30.09.22	Condition is same in last 15 days, wheezing is still there, occasional use of bronchodilators.	16	Bryonia 30 single dose in 40 size globules, along with Placebo in 40 size globules thrice a day for 7 days
4	08.10.22	Symptoms were significantly relieved, no disturbance in sleep due to cough and shortness of breath in last 7 days. Not used bronchodilator in last 7 days. Slight wheezing is present. Which aggravates after physical exertion, but subsides after rest.	8	Placebo in 40 size globules thrice a day for 15 days.
5	21.10.22	No episode of cough, and no nocturnal breathlessness was reported. No new complaint was reported. FEV_1 predicted was 90 %	5	Placebo in 40 size globules thrice a day for 30 days

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Fig.1: Case repertorised by using Synergy Homoeopathic Software

RESEARCH ARTICLE

Denoising using Filters and Various Wavelet Transformation

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ABSTRACT

Most widely using Denoising methods will include filters, but it will not remove the noise completely whereas Wavelet transforms will remove noise in a better way. In this paper, various noises are introduced in the sample images and it was removed using filters or wavelet transformations. Some of the filters used in this paper are im filter, f special, speckle, Gaussian, salt & pepper, median, wiener, motion blurred filter etc. Some of the wavelet transforms used are DWT, DTCWT, Haar & TWT etc. while Denoising using filters, elapsed time was calculated and for wavelet transforms MSE & PSNR values are calculated and compared.

Keywords: DWT, DTCWT, TWT, Haar

INTRODUCTION

A nice picture conveys exactly the words that you think & feel. But if the picture contains noise, then it won't give you satisfaction. For CT images, it should be clear. So that physician can diagnose the disease accurately & noise removal plays an important role. In this paper, various denoising methods like applying filters and wavelets are applied over the image and then MSE & PSNR values are calculated. We can achieve better generalization over different noise levels for denoising approaches[1]. Some of the commonly introduced noises are Gaussian noise model, White noise, Brownian noise, Impulse noise, Salt and Pepper noise, Shot noise, Periodic noise, Speckle noise, Photon noise or Poisson noise, Structured noise, Gamma noise, Rayleigh noise etc. The process of removal of noises is called as Denoising.

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DENOISING USING FILTERS

An image is introduced with noise and then it is passed under several noise removal filters, name of the filters with its elapsed time are given in table 1. When we take an MRI image, Poisson-Gaussian noise is mostly produced. Sometimes while taking images of moving objects, it will make the light into beautiful streaks of colour in motion blurred image. While doing some of the jobs like echo cancellation, signal restoration, wiener filter plays a major role. It will reduce the output signal and averaged squared distance signals by calculating the coefficients of wiener filter. While doing noise removal, preservation of edges are done by median filter. It is one of the important noise removal filtering technique from images and signals.

CALCULATING MSE & PSNR VALUES

Noise removal will be better if it is done through wavelets instead of filters. So wavelet transformation was used for noise removal like discrete wavelet transformation and dual tree complex wavelet transformation are also used. It is far better than regular usage of filters.

DWT & TWT

Discrete wavelet Transformation and Toggle Wavelet Transformation are used for noise removal. Both the method uses wavelet transforms with more co efficient which is able to find location and number of times information. So it is efficient one. For DWT, the samples are discretely sampled and it will more efficient then Fourier transformation. Different types of noises are introduced for different images and values are calculated and tabulated in table 4. Usually there are different noises and they will be removed or reduced without compromising the information captured from the observed scene by using bilateral filtering[2] is one of the most popular denoising approaches[3].

HAAR & TWT

We can select any arbitrary term for the processing tasks like image denoising using Probability Distribution Equation (PDE) & combinations of many PDEs[5]. Usually edge detection methods which use wavelet threshold denoising techniques are commonly used to save more edge information from loss to enhance the quality of the denoised image[6]. The deep wavelet multi scale autonomous unmanned analysis based medical image denoising in real time and information hiding model are producing far better results[7]. Wavelet-based global–local filtering networks include a base image plus three-directional detail images by applying discrete wavelet transform in a noisy image and Aim of inverse discrete wavelet transform is to build high-quality images with all processed components[8].

CONCLUSION

Image Denoising plays a crucial role in medical imaging. Initially filters are used for Denoising. Their experimental results were discussed. Then Denoising were done with the help of wavelet transformations, in this paper discrete wavelet transformation (DWT), dual tree complex wavelet transformation (DTCWT) and Toggle wavelet transformation were applied in noisy image and their results were discussed in terms of PSNR (peak-signal-to- noise-ratio) & MSE (Mean Squared Error) values. From above results, it is clearly proved that wavelet transformations are best in image Denoising.

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Table 1: Elapsed time for the Tic & Toc **commands used**

Noise Removal filters	
Command Name	Elapsed time (in seconds)
Imfilter	0.056884
fspecial	0.036882
speckle	0.489691
gaussian	0.489460
salt & pepper	0.213972
median	0.452338
wiener	0.741304
N ise Removal in Edge commands	
Command Name	Elapsed time(in seconds)
edge	18.487140
sobel	18.632645
prewitt	18.958424
roberts	19.179785
canny	2.951014
log	0.739765

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log	0.739765

Table 2: Different types of filters with their PSNR values

S no	Filters Name	PSNR (in db)
1	Motion blurred	18.27
2	Wiener	15.82
3	Median	12.10

Table 3: MSE & PSNR values for DWT & DTCWT

Sno	Noise	Noise variance (σ)	MSE value (Dual Tree Complex Wavelet Transform)	MSE value (Dual Tree Complex Wavelet Transform)	SNR Value (Discrete Wavelet Transform)	PSNR Value (Dual Tree Complex Wavelet Transform)
1.	Salt and pepper	11	43	1.71	1.87	4.44
2.	speckle	21	52	3.34	9.37	1.42
3.	Poissonnoise	24	71	1.71	3.28	0.43
4.	Gaussiannoise	9	81	2.31	3.28	1.74

Table 4: Noise variance levels and their corresponding PSNR values for DWT, DTCWT

Image Noise Removal methods				
	Discrete Wavelet Transformation		Toggle Wavelet Transformation	
	First analysis	Second analysis	First analysis	Second analysis
MSE	92.01	92.222	93.954	94.260
PSNR	27.0785	26.85	28.40	28.388
MSE	80.50	80.45	82.60	82.67
PSNR	27.55	27.52	28.961	28.961
MSE	80.325	80.400	82.397	82.099
PSNR	27.122	27.345	28.972	28.987
MSE	93.946	93.774	92.233	91.995
PSNR	28.402	28.410	29.320	29.628

Table 5: Comparative results for Discrete (DWT) and Toggle wavelet transforms (TWT)

sno	Noise	Noise variance	MSE value	PSNR Value (DWT)	PSNR Value (DTCWT)
	Salt & pepper	15	2.5329	30.3421	33.542
	speckle	25	17.7231	29.0227	29.147
	Poisson noise	30	10.2556	22.9197	31.955
	Multi typenoise	35	7.709	21.2542	30.015

Table 6: Comparative results for Haar and Toggle wavelet transforms

	MSE (Haar)	PSNR (Haar)	Execution Time(Haar)	MSE (TWT)	PSNR (TWT)	Execution time(TWT)
First Level	55.97	49.55	1.003	54.13	49.09	0.83
Second Level	50.28	21.78	0.78	52.46	22	0.62
Third Level	28.32	19.25	0.005	20.26	20.84	0.43

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Table 7: Comparative results for Bilateral and spatial filters

SN	Noise	Bilateral Filters PSNR (in db)	Spatial Filters PSNR (in db)
·	Salt and pepper	16.72	15.85
·	Speckle	17.89	18.12
·	Wiener	14.12	12.88
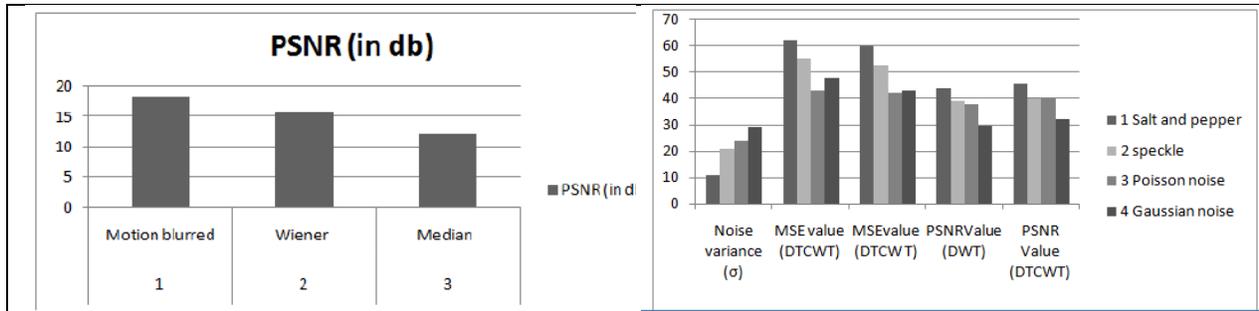
Graph 1: Various filters & their PSNR values	**Graph 2: Various filter with their MSE & PSNR values**

Graph 3: MSE values for Bilateral & Spatial Filters

RESEARCH ARTICLE

Evaluating Endophytic Fungi from Medicinal Plants for Plant Growth Promoting Activities

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ABSTRACT

Endophytes are an imperative component of plant micro-ecosystems, residing beneath the healthy epidermal tissues without causing probable diseases and a good source for agriculture applications and pharmaceuticals. The aim of this study was to investigate isolated fungal diversity and their evaluation for Plant Growth Promoting Activities (PGPA).Eight different terrestrial plant systems were selected on the basis of their higher medicinal value in daily life needs. Stem bark was used as an explant and a total of 13 fungal isolates were obtained. All the fungal strains were identified on the basis of their growth morphology and their microscopic view. Three different classes were represented by 13 isolates, out of which 10 come under Eurotiomycetes, one in Incertaesedis, and 2 in Sordariomycetes, respectively. Test organisms (Salmonella typhimurium, Pseudomonas aeroginosa) were used to check the antimicrobial activity of isolates. All the fungal isolates were screened for their PGP activities by performing different assays such as Phosphate solubilizing assay, Indole-3-acetic acid test, amylase activity, Cellulose degrading activity, Hydrogen cyanide production activity, and Ammonia production activity respectively. Most of the isolates were good candidate for plant growth promotion, but few of them have very significant ability.

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As per gill us niger and As per gill us sp. Has shown good activity in almost all plant growth promoting tests (*In vitro*). In the future, these isolates might be used for plant growth promoting (PGP) purposes in field condition.

Keywords: Endophytes,terrestrial plant, PGPA, *In vitro* tests.

INTRODUCTION

The wide range of Indian ecosystems has a great diversity of medicinal plants, approximately 8000 species out of 17000 species of higher plants, have similar properties as conventional pharmaceutical drugs and they are considered medicinal and used in the synthesis of different drugs [1]. Nowadays, the use of medicinal plants is widely spread throughout the world because it is considered a common cheaper herbal drug substitute and has less side effects. These are utilized for a large number of years to flavour and preserve food products. Several plants also show antimicrobial activity on the basis of their chemical compositionand also well known to harbor number of endo symbitiotic fungi that might be associated with the production of pharmaceutical products. They produce number of bioactive compounds utilized throughout the globe for different purposes. The temperate region and tropical rainforest have a great biological diversity of endophytic fungi, where approximately 300,000 host plant species are naturally distributed [2].So, it is important to explore more endophytic myco flora in the most familiar medicinal plants which were easily available in surrounding area. Endophytes are meiosporic and mitosporic organisms, which are widely existinside the healthy tissues (root, stem, leaf, fruit and seed etc.) of living plants via quiescent infections, until the end of its entire life and also utilized by plant as an indirect defense against herbivores by secreting bioactive secondary metabolites. These organisms are good source of antibiotics belong to the phylum Ascomycota, showsa symbiotic relationship with host plant, inhabit the internal tissues of plants underneath the epidermal cells layer [3]. It provides several benefits to the plant which can include essential nutrient uptake and protection from insects that are feeding on them and birds or mammals. The relationship between endophytic fungus and their host plant species is still limited because this interaction is not completely understood.

The endophytic fungus has ability to produce wide variety of new bioactive secondary metabolites that are used for making various natural products by industries. The existence of this symbiotic organisms in host plant plays a significant role in their metabolic system that influences the growth and development of the plant. So, the host plants make long term co-evolution with pathogen as a resistance mechanism and produce various secondary metabolites [3].Endophytes are omnipresent and isolated almost from all groups of plant species ranging from sea grasses to large trees in ecosystem. In earlier studies, several endophytic strains have been identified from many host plants, including cereal crops, cereal grains, fruits, vegetables and also from other tree species. These are also a good source of bioactive products which helps in the improvement the nutritional value of host plant and enhance the resistance toward pest, disease and physical stress [4, 5] and these compounds (alkaloids, flavinoids, terpenoids, steroids, phenols, phenolic acids, tannins and peptides) can be used in food, agricultural and pharmaceutical industries which act as an enzyme and shows antimicrobial and anti-malarial activities [6]. An important example of such usage of these secondary metabolites is Taxol which is an anticancer agent produced by endophytic fungi (Taxomycesandrenae) of Hypomycetes class [6]. Plant tissues gets inhabited by PGPE (plant growth promoting endophytes), show close linkage inside plant tissues and facilitates enzyme activities and nutrients exchange [7, 8]. Endophytes possess dynamic potential to activate insoluble phosphate and also supply proper nitrogen content to their host plant [9, 10]. Previous studies improved our knowledge regarding the association of endophytic fungi with their host plant and also described the effects of various waves of biotic and abiotic stresses on endosymbiotic plants [11, 12, 13, 14]. However, these are also beneficial to the host plantin terms of higher PGR hormones production which might be showed their antagonistic behavior against pest and pathogens [15, 16]. These endophytes secreted phytohormones (gibberellic acid and IAA) or plant growth regulating compounds which lead to enhance the quality, production rate, influence development of plants and might be growth of different host plants in a stressful environment [17, 18, 19]. No more studies have been found yet related to PGP mechanisms of endophytic fungi

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leading to enhancement of plant growth. Endophytic isolates of *Oryza sativa* and Limoniumsinense showed adaptable plant growth-promoting activities including phosphate solubilization, nitrogen-fixation and IAA synthesis [20, 21].

In this work, we have taken some familiar medicinal plants for the isolation of endophytic fungi because they have more importance in the medical and Agriculture (such as, Eucalyptus globulus, *Mangifera indica*, *Acacia nilotica*, *Terminalia arjuna*, *Sesbania grandiflora*, *Psidium guajava*, *Syzygium cumini* and *Calotropis procera*), so we tried to identify some endo symbiotic fungi which directly and indirectly play a key role in the plant growth and development. Several different fungal strains were isolated using stem portion as an explant from these herbal plants. However, with the help of these isolates, we were able to check their Plant growth-promoting activity using different compositions of media. As per the PGP activities results, we can assume that these isolated organisms might be responsible for influencing the growth and other fitness parameters of plants.

MATERIALS AND METHODS

Plant material collection and sterilization
The plant materials were collected from fully matured medicinal plants of the surrounding area of Mullana and Jagadhari (Haryana) in between the month January and February of 2018. The fresh, healthy ordisease-free stem part were collected from *Eucalyptus globulus, Mangifera indica, Acacia nilotica, Terminalia arjuna, Sesbania grandiflora, Psidium guajava, Syzygium cumini* and *Calotropis procera*, excised carefully with sterile scalpel and kept inside the sterile poly bags and brought to the laboratory for storage at 4°C.

Isolation of Endophytic fungi
An altered method was used for the isolation of endophytes from plant explants already reported by Arnold et al. [22].All stem explants were cut into small pieces (0.5-1.0 cm) and washed thoroughly before processing under the running tap water. Surface sterilization of explants were done by soaking the material in 70% ethanol for 1 minute, followed by 2 minutes (0.1%) mercuric chloride ($HgCl_2$) treatment and rinsed with double distilled autoclaved water for 4-5 times to remove the remnants of sterilizing agents. After air drying, the explants and inner tissues were kept in petri-dishes having aqueous agar (1.5%) supplemented with (3mg/100ml) streptomycin antibiotic and incubated at 25-28°C to initiate the mycelia growth. Mycological medium (i.e., PDA) was used to culture grown mycelium, supplemented with concentrations of Streptomycin as mentioned previously and plates were incubated properly at 28 ± 2°C to complete their growth cycle. Morphological colonies of each fungal culture described the purity and transfer the final culture to slant tubes of PDA. To examine the contaminated endophytic fungi, as a control, non-disinfected section of surface-sterilized explants was also placed over the same agar medium concentration (1.5%).

Identification of Endophytic Fungi
Macroscopic study
Morphological identification of all isolated fungal culture was done by culturing each culture on PDA medium plates (without streptomycin) for seven days, continuously observe the growth appearance on both sides of culture plates (top and bottom) on the basis of the standard taxonomic key, we were able to identify each culture, according to their color, diameter of fungal colony, texture, morphology and dimensions of conidia and hyphae [23, 24].

Microscopic study
By using tease mount method, microscopic slides of each isolated fungal culture were prepared using Lacto phenol cotton blue reagent for tentative recognition and observed each slide under Electron microscope (Compound microscope) through 40×100 magnifying lenses [25]. According to the characteristics of culture, formation of mycelium and spores helps us to identify all the unknown isolated endophytic fungi.

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Colonization frequency

To calculate the Colonization frequency percentage of each isolated fungal culture, following formula described below [26].

$$\text{CF (\%)} = \frac{\text{No. of segments colonized by isolated fungi}}{\text{Total no. of segments examined}} \times 100$$

Plant Growth Promoting Activities (PGPA)

Phosphate solubilizing assay

To check the phosphate solubilizing capacity, each isolated fungal culture inoculated on the Pikovskyas agar medium plates separately and incubated at 25-28°C for 48-72 hours[27].

Indole-3-acetic acid (IAA) synthesis test

Fungal cultures were dipped into LB broth conical flasks supplemented with tryptophan, incubated at 25°C in BOD shaker for 48 hours. After incubation, using Whatman No.1 filter paper, filter the grown culture and centrifuge the filtrate. Add 1-2 ml of Salkowski's reagent in the supernatant of fungal culture, kept in dark at room temperature for 30 minutes [28].

Antimicrobial activity

To check the antimicrobial activity of each fungal isolate, test organisms (*Salmonella typhimurium, Pseudomonas aeroginosa*) were taken from the MTCC (Microbial Type Culture Collection) Chandigarh (India),streaked around the fungal culture discs in PDA plates and incubated at 25°C for 24-48 hours [29].

Amylase activity

Fungal culture were cut into small discs with the help of sterilized cork borer and placed over the GYEPA medium plates (Glucose- 0.5g, Yeast extract- 0.05g, peptone- 0.25g, agar- 8g, and pH-6) supplemented with 1% soluble starch and incubate at 25-28°C for 5 days. After incubation, cultured plates were flooded with 1% iodine and 2% potassium iodide [30].

Cellulose degrading activity

Equal sized fungal cultures were placed over the Carboxyl methyl cellulose (CMC) agar plates (1% CMC, 1M NaCl, 1.5% agar and 0.01% congo red) and analysed qualitatively using agar diffusion method. After the incubation of 72-96 hours at 30°C, plates were flooded with congo red solution destained using 1M NaCl for 15 minutes, however the formation of clear zone around isolates indicate the cellulose activity [31].

Hydrogen cyanide (HCN) production activity (Cyanogenesis)

Fungal culture discs were kept over the Nutrient agar medium plates, covered with lid having picric acid solution dipped What man filter paper inside and incubated at 25-28°C for 7 days in an inverted manner [32].

Ammonia production activity

Peptone medium (Broth) were inoculated with different fungal culture discs separately, and incubated at 27°C for 48-72 hours. After incubation, 0.5ml of Nessler's reagent was added individually over the fungal growth in each conical flask [33].

RESULTS AND DISCUSSION

As reported earlier, most of the isolated endophytic fungal strains have been described on the basis of their morphological characters (peridium and ascospore morphology, gleba, odour and colour) observed in microscopic

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view [34] however, at species level, it seems to be very difficult to identify them because of small set of homoplasy and morphological features [34]. Now a day, researchers progressively worked on the extraction of endophytic fungi from different medically important plants to check their activity against malignant tumor cells. To check the cytotoxicity, a total of 172 endophytic fungal strains were isolated from 3 medicinal plants and after tested their fermentation broths they showed cytotoxicity of 50% growth inhibition [35]. To evaluate the various bioactivities, crude extract of 51 isolated endophytic fungal strains were used which were isolated from Garcinia plant and their results showed cytotoxic activity against KB, NCIH187 cell and Vero respectively [36]. Several noteworthy fungal isolates were obtained from endophytic fungi that synthesize bioactive compounds that fulfill the needs of pharmaceutical industries and agriculture and these compounds can also be used as lead molecule for the development of novel drug [2]. Endophytic fungi commonly found from different medicinal plants, may produce bioactive compounds for pathogenic inhibition. In present study, total 13 endophytic fungal strains were isolated(1 from Eucalyptus globules, 4 from *Mangifera indica*, 2 from *Acacia nilotica*, 1 from *Terminalia arjuna*, 1 from *Sesbania grandiflora*, 1 from *Psidium guajava*, 1 from *Synzium cumini* and 2 from *Calotropins procera*)using selective media from 8 medicinal plants those were used to very useful in daily life. In India, all these medicinal plants are very much familiar and has been used for years. However, this analysis is the first report from familiar medicinal plants that describes how the endo symbiotic fungal strains involved in Plant Growth Promoting Activities. Total of thirteen endophytic fungi was reported from eight medicinal plants of medicinal value. According to the standard protocol of Aggarwal and Hasija (1980) and Barnett and Hunter (1998), all the isolated fungal strains were identified and characterized on the basis of their micros copical and cultural properties [24, 37].Out of 13 dissimilar strains, 10 strains belong to Eurotiomycetes class, 2belong to Sordariomycetes class and 1 was belong to Incertaesedis, as depicted in Table 1.All the strains were morphologically dissimilar and each culture was encoded by a different unique code to maintain properly in the laboratory. Isolated *Aspergillus* strains showed CF ranging from 1.22 % to 5.34%, *Penicillium* species strain showed 4.76%- 8.33% CF, *Chaetomium* species showed 12.69% CF and one *Ascomycete Incertaesedis* sp. strain showed 9.52% of (CF) colonization frequency.

Screening of endophytic fungi for Plant Growth Promoting Activities (PGPA)

Isolated endophytic fungal cultures were screened to determine the various plant growth promoting activities (Phosphate solubilizing activity, IAA synthesis test, Amylase production activity, Cellulolytic activity, HCN production activity, Ammonia production activity) and antimicrobial activity against *Salmonella typhimurium, Pseudomonas aeroginosa* test organisms. The solubilizing activity of each fungal isolate were measured on the basis of colony diameter and halo zone. SK4 (*Aspergillus niger*) and SK8 (*Penicillium* sp.) culture formed clear halozones on the medium plates which revealed that they can solubilize tri- calcium phosphate which indicate the formation of potential organic acids leads to promoting plant growth traits[38, 39, 40]. IAA synthesis rate of all the isolated organisms were described on the basis of change in colour of LB culture to pink colour, compare the control one (without fungal culture)after treated with Salkowski's reagent. Out of thirteen isolates, three (*Aspergillus terreus, Penicillium* sp. and *Chaetomium* sp.) produced higher concentration of IAA which was most relatable to the previous studies of induction IAA from *Pseudomonas aeruginosa* organism from *Liliumlanci folium*[41, 42]. *Salmonella typhimurium, Pseudomonas aeruginosa* test organisms were used to check the antimicrobial activity using disc diffusion method but none of the isolated fungal strains exhibit any activity, only mutualistic growth observed over the plates. Isolate SK4 (*Aspergillus niger*), SK8 (*Penicillium* sp.) and SK10 (*Aspergillus flavus*) were found to be higher amylase producer with maximum amylase activity and other isolates showed low amylase activity.

Qualitative analysis of Cellulolytic activity revealed the presence of maximum zone of inhibition around the fungal colony of *Chaetomium* sps. (5-6mm) shows its potential producer character of cellulase enzyme and is observed to be prominent in degrading cellulose content. Similar results were reported in previous study of isolated *Penicillium* sp. from Tumakuru medicinal plant [43].Three fungal cultures SK4 (*Aspergillus niger*), SK11 (*Ascomycete Incertaesedis* sp.) and SK14 (A) (*Aspergillus* sp.) produced higher concentration of (HCN) hydrogen cyanide. Similarly in previous study *Pseudomonas fluorescens* isolate from Fababean used as a plant growth promoter and also defence against the plant pathogens [44].Ten cultures exhibited the ammonia production activity, indicated by the change in color from brown to yellow broth media by addition of Nessler's reagent [33], presented in Table 3.In this work, most of the

isolates showed plant growth promoting activity (PGPA) but *Chaetomium* sp. was observed to be most active fungal stain as compared to others. Isolates were assessed for plant growth promoting activity (PGPA) through In dole Acetic activity, Phosphate solubilization, ammonia production, Hydrogen cyanide (HCN) production and anti-pathogenic activities. Similarly in earlier studies, isolated fungal strains from different plants were proved for their crucial function for improvement in plant growth [45, 38]. They also evaluate for their cellulolytic activity and amylase production potential. Most of the isolates were good candidate for plant growth promotion, but few of them have very significant ability. *Aspergillus niger* and *Aspergillus* sp. Has shown good activity in almost all plant growth promoting tests (In vitro). In future, these isolates might be used for plant growth promoting (PGP) purposes in field condition.

ACKNOWLEDGEMENTS

ABBREVIATIONS

PGPA   Plant Growth Promoting Activities
PGR   Plant Growth Regulator
IAA   Indole-3-acetic acid
PDA   Potato DExtrose Agar
CF%   Colonization frequency percentage
MTCC   Microbial Type Culture Collection
GYEPA   Glucose, Yeast Extract, Peptone and Agar
CMC   Carboxyl methyl cellulose
HCN   Hydrogen cyanide

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Table 1: Endophytic fungi isolated from stem of different medicinal plants

Sr.No.	Name of the Plant	Isolates	Name of Endophytic fungi	Class
1)	*Eucalyptus globules*	SK2	*A.terreus*	Eurotiomycetes
2)	*Mangifera indica*	SK4(S)	*A. nidulus*	Eurotiomycetes
		SK4	*A.niger*	Eurotiomycetes
		SK9	*Aspergillus versicolor* and *Trichodermacitrino viride*	Eurotiomycetes And

					Sordariomycetes
3)	*Acacia nilotica*	SK5	*Penicillium* sp.		Eurotiomycetes
		SK6	*Aspergillus flavus*		Eurotiomycetes
4)	*Terminalia arjuna*	SK7	*Chaetomium globosum*		Sordariomycetes
5)	*Sesbaniam grandiflora*	SK8	*Penicillium* sp.		Eurotiomycetes
6)	*Psidium guajava*	SK10	*Aspergillus flavus*		Eurotiomycetes
7)	*Syzygiumm cumini*	SK11	*Ascomycetes Incertae sedis* sp.		Incertaesedis
8)	*Calotropism procera*	SK14(A)	*Aspergillus* sp.		Eurotiomycetes
		SK14(B)	*Aspergillus terreus*		Eurotiomycetes

Table 2: Name and colonizing frequency of Endophytic fungi isolated from different medicinal plants

Sr.No.	Name of Endophytic fungi	Plant part	% Frequency of colonization
1)	*A.terreus*	Stem	2.54%
2)	*A. nidulus*	Stem	1.78%
	A.niger		4.16%
	Aspergillus awamori		2.77%
3)	*Penicillium* sp.	Stem	4.76%
	Aspergillus flavus		1.22%
4)	*Chaetomium* sp.	Stem	12.69%
5)	*Penicillium* sp.	Stem	8.33%
6)	*Aspergillus flavus*	Stem	1.58%
7)	*AscomyceteIncertaesedis* sp.	Stem	9.52%
8)	*Aspergillus sp.*	Stem	3.67%
	Aspergillusterreus		5.34%

Table no. 3: Screening of isolated fungal cultures for Antimicrobial and Plant Growth Promoting Activity

Organism	Isolates	Antimicrobial activity	Phosphate Solubilising activity Zone of clearance(mm)	IAA production / concentration	Amylase production activity (diameter of zone (mm))	Cellulolytic activity (diameter of zone of clearance)	HCN production activity	Ammonia production
A.terreus	SK2	-	-	**+++/High**	-	-	+	-
A. nidulus	SK4(S)	-	-	++/Medium	-	0.1mm	-	**+++**
A.niger	SK4	**-**	**+ (9mm)**	+/Low	**3-4mm**	-	-	**+++**
Aspergillus versicolor	SK9	-	-	-	-	-	-	++
Penicillium sp.	SK5	-	-	**+++/High**	-	-	-	++
Aspergillus flavus	SK6	**-**	**-**	-	-	1mm	-	-
Chaetomium sp.	SK7	-	**+ (2mm)**	**+++/High**	**1-2mm**	**5-6mm**	-	++

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Penicillium sp.	SK8	-	**+ (6mm(clear), 14mm(unclear))**	-	-	-	-	++
Aspergillus flavus	SK10	-	-	+/Low	**1-2mm**	-	-	++
Unknown	SK11	-	-	++/Medium	-	-	+	+
Aspergillus sp.	SK14(A)	-	-	-	-	1-2mm	+	**+++**
Aspergillusterreus	SK14(B)	-	-	+/Low	-	1mm	-	++
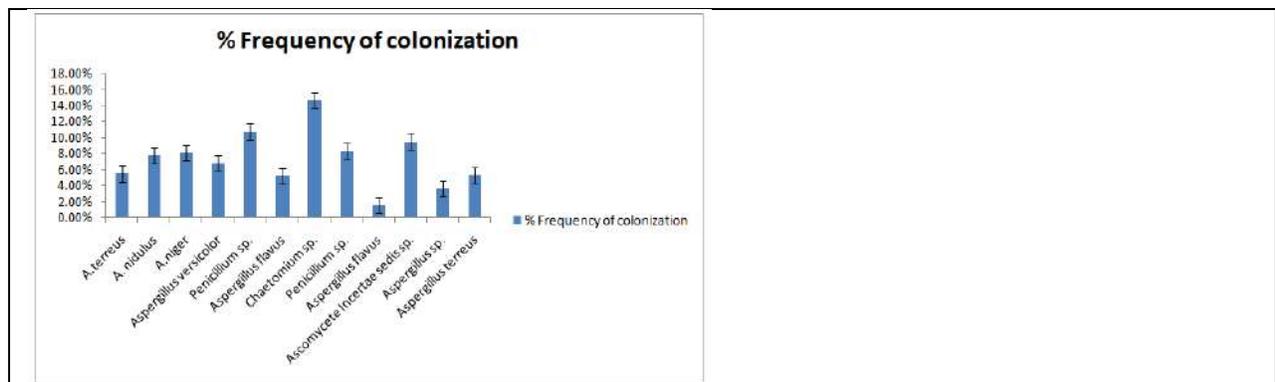
Figure 1: Colonizing frequency (%) of endophytic fungi isolated from different medicinal plants
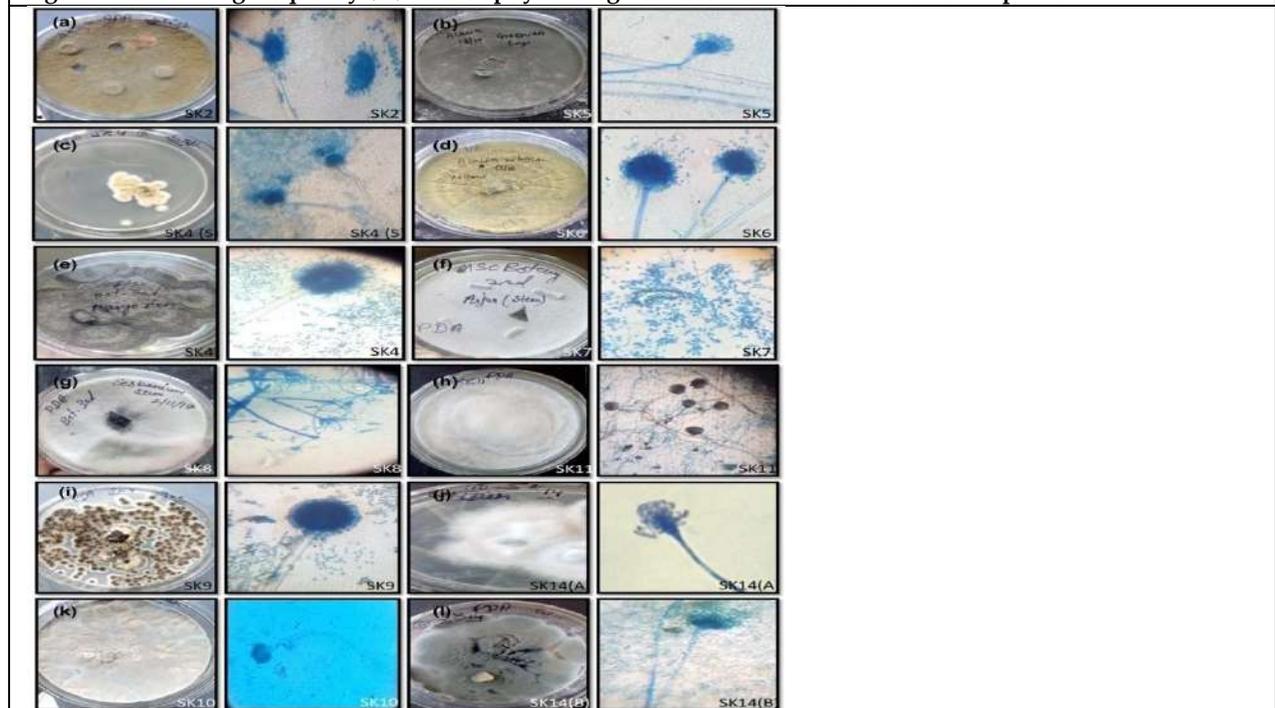
Figure 2:Morphology (colony appearance) and microscopic (conidia, hypha) view of all isolated endophytic fungal cultures
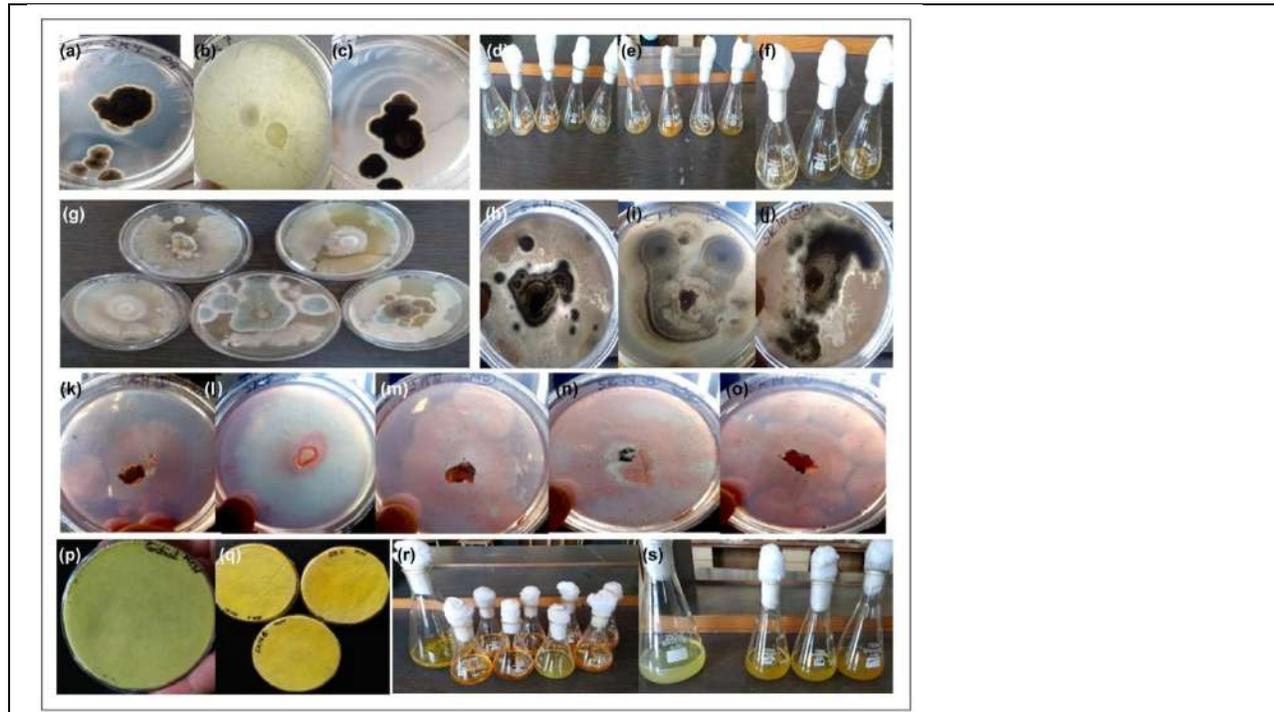
Figure 3: Phosphate Solubilization activity (a-SK4, b-SK7, c-SK8); IAA Synthesis test (d and e- fungal culture testing by addingSalkowski's reagent , f- control (only fungal culture)); g- Antimicrobial activity; Amylase activity (h-SK4, i-SK7, j-SK10); Cellulose degrading activity (k-SK4(S), l- SK6, m-SK7, n-SK14(A), o-SK14(B)); HCN production activity (p- control (without fungal culture), q-HCN testing with three different fungal strains); r and s- Ammonia production activity.

RESEARCH ARTICLE

Impact of Levels of Disability in Cerebral Palsy Children over Physical Health of Mothers

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ABSTRACT

the impairments leads to loss of functional abilities and mobility. Mothers care-giving for a child with functional limitations and long-term dependence influences mothers' QoL in terms of physical and emotional functioning. This increases the workload of day- to- day life activities of mother lead to deterioration of health and quality of life. Active participation of mothers in handling the children with cerebral palsy has a great effect on rehabilitation of children. To find out the impact of levels of disability in cerebral palsy children over physical health of mothers. It is an observational study with 45 mothers and cerebral palsy children were included in the study. Children with spastic cerebral palsy; from 4-6 years of age; Both genders and mothers who are primary care givers of cerebral palsy children. Children with cerebral palsy were assessed for their different levels of disability by using Gross motor function classification of system (GMFCS). Similarly, Mothers of cerebral palsy children were checked for the presence of physical health problems in taking care of their children. Physical health problems of mothers handling various levels of disability cerebral palsy children were analyzed using the percentage. Mother's handling cerebral palsy children, more commonly suffered with back pain, shoulder pain and knee pain especially those who handle level III, IV, V disability children. Awareness and early identification of these physical health problems and their management may improve quality of life of mothers and also will help in better handling of their children.

Keywords: Levels of disability in cerebral palsy children, physical health problems, quality of life of mothers.

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INTRODUCTION

Cerebral palsy occurs due to damage of the developing brain during pregnancy, birth or shortly after birth which results in physical disability. Cerebral palsy is one of the most common physical disabilities in children with a prevalence of 2 per 1000 live births. Cerebral palsy is creating a wide range of impairments in children [2,3], including abnormal muscle tone, decreased motor control, muscle weakness, balance deficits [4]. scoliosis, hip dislocation and contractures of soft tissues[5]. In addition, these impairments can influence a wide range of functional abilities such activities of daily living (dressing and toileting) and mobility (transfers and ambulation) depending on the severity of the condition. As children in cerebral palsy age, they are at risk for health complications and loss of ambulation and functional mobility skills [6]. Cerebral palsy children have reduced range of motion at various joints of their bodies and this is because of the muscle stiffness. Also, cerebral palsy children have limitations in play due to some restrictions in movement, sensory processing, cognitive abilities and their environment and social interactions. Spastic cerebral palsy may result in increased muscle tone, stiffness and involuntary movements. Spasticity may cause shortening and rigidity of muscles, which can worsen if not treated. Cerebral palsy children may undergo frequent injuries and trauma. Especially with increased scores in GMFCS levels. Care-giving is a natural role of mothers, however, providing care for a child with functional limitations and long-term dependence is entirely different and influences mother's QoL in terms of physical and emotional functioning [7]. Mothers of children with Cerebral palsy have significant roles in the management and the treatment of Cerebral palsy. Care giving includes various activities such as lifting, heavy lifting and turning providing assistance for ADL-using toileting, dressing, transfers etc. Manual handling can put physical strain on mothers and be a contributing factor to a higher pain severity [8,9]. The caregivers' physical demands gradually increase over time as the child grow. Consequently, musculoskeletal system problems become prevalent and challenging health matters among the caregivers of a child with Cerebral Palsy. These may impact upon both the physical and mental health of the caregivers especially mothers. Changes in healthcare systems and societal attitudes have resulted in almost all children remaining at home in the care of their families. Poor caregiver health has negative implications of child, family and community, resulting in decreased production of work and that increases the healthcare costs of the caregiver [10]. The main challenges for parents is in managing chronic health problems of the disabled child and the requirements of everyday living. Although increasing attention has been given to the quality of life of children with cerebral palsy, much less attention has been given to the health and quality of life of parents of children with cerebral palsy. Mothers who is taking care of a cerebral palsy children, may suffer with lots of physical health problems specially like neck pain, shoulder pain, back pain & fatigue [11]. This increase in workload of day- to- day life activities of mother lead to deterioration of health and quality of life. Active participation of mothers in their therapy for physical health problems has a great effect on rehabilitation of children. If they fail, the children may suffer. Health professionals working in the area of childhood disability must be aware of the relatively poorer quality of life of primary caregivers. More attention is to be given to their needs. Especially in chronic disorders patient's parents are exposed to cumulative trauma, because of their children's transfers, bathroom activities, school activities etc [12]. These activities include prolonged static postures such as slouched sitting and forward bending as well as repetitive tasks like pulling, lifting and carrying. Poor posture and faulty body mechanics used during home and work activities contribute substantially to Low Back Pain (LBP).[13] And also, low back pain is influenced by the interaction of physical, mental and social factors. There is a need for specific aim to improve the well-being of caregivers of children of cerebral palsy.

These have been related to the higher demand of care that their child's disability requires of them. All of these initiatives indicate an important role for the study and promotion of the health of care givers of children with chronic conditions involving health or development and to improve quality of life of mothers who are the primary caregivers.

AIM OF THE STUDY

To find out the impact of levels of disability in cerebral palsy children over physical health of mothers.

METHODOLOGY

Site of the study: Vidya Sudha, Sri Ramachandra Learning Centre for Children with Special needs.
Study Design: Observational study
Sampling method: Convenient Sampling
Sample size: 45

Inclusion Criteria: Children with spastic cerebral palsy; from 4-6 years of age; Both genders Mothers who were primary care givers of cerebral palsy children.

Exclusion Criteria: Mothers of cerebral palsy children who were unwilling to participate.

PROCEDURE FOR DATA COLLECTION

This study has been approved by the Ethics committee for students projects with reference no: CSP/23/APR/127/359.The Children's and mothers who met the inclusion criteria were included in the study. Informed consent was obtained from mothers of cerebral palsy children. Children with cerebral palsy were assessed for their different levels of disability by using Gross motor function classification of system (GMFCS).   Similarly, Mothers of cerebral palsy children were checked for the presence of physical health problems like neck pain, shoulder pain, back pain, knee pain, hip pain, ankle pain & fatigue.

RESULTS AND DISCUSSION

Physical health problems of mothers handling various levels of disability cerebral palsy children were analyzed using the percentage. When analyzing physical health problems in mothers handling in level-I disability cerebral palsy children, it was found that only one mother was under this category and she was found to be suffering from back pain and hip pain. In this study five children had level II disability, their mothers suffered from physical health problems in the order of shoulder pain, back pain, upper limb pain, neck pain, knee, ankle and fatigue respectively. Mothers had more number of physical health problems like more back pain, upper limb pain, neck pain and fatigue. Nobody had hip pain, ankle pain and knee pain. Children dependency is more on their mothers and that results in more physical problems. In children with level-IV disability needs help for sitting, walks with assistance, but cannot turn or balance or uneven surfaces, self-mobility can be only with a powered wheelchair. So, mothers had to lift and assist the child for their transfers, due to this mother suffers with physical health problems particularly back pain, neck pain, shoulder pain, upper limb pain, knee pain. Children need in level-V needs assistance for sitting and walking need help from mothers, mobility with a powered wheelchair. Mothers had more physical health problems with back pain, shoulder pain, fatigue, knee pain, hip pain with no ankle pain. As child completely depends on mother for their daily living activities, physical health problem was more severe. In comparing all the levels of disability using gross motor functional classification system mothers with level III, IV and V children had more number of physical health problems like shoulder pain, neck pain, back pain, knee pain and fatigue comparing with the other pains. Because, these children were confined mostly to the wheelchairs, also gaining weight due to lack of movements and needed increased the dependence of mother. This resulted in more number of physical health problem in mothers.

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Additionally in our study, we have found that mothers also complained of heel pain, numbness of foot, calf muscle catch, numbness of hand, abdominal sprain, giddiness, elbow pain, restlessness and breathing difficultly. As the functional levels of children with cerebral palsy get worse upper limb pain, shoulder pain, neck pain, knee pain and fatigue increased and negatively influenced the quality of life of mothers. When the level of functional dependence increases in cerebral palsy children, there was an extensive physical health burden on mothers who were handling them. These physical health problems increased during lifting, carrying, transfer activities in particular. Similarly, Leaning forward, rotation, lifting, pushing and pulling movements by mothers during care of their disabled children and their activities of bathing, clothing, carrying and feeding their children created an increasing stress on musculoskeletal systems of mothers [14]. Physical activities along with the overweight and low level of education were contributors to suffering from chronic pains among the mothers of cerebral palsy-children [15]. In addition, children with moderate-to-severe motor disabilities have lack of ability to walk independently and transfer of children becomes difficult as the child's age and body mass index increases [16]. As a result, we can say that mothers with children in cerebral palsy were more affected in terms of musculoskeletal pains and quality of life [17]. So, it is important in teaching and training the mothers who are handling cerebral palsy children with number of simple and home exercises like isometric neck exercise, stretches for back muscles, upper extremities, quadriceps muscle and calf muscles, hot packs and cold packs for pain, massage, relaxation techniques, yoga. Such simple exercises may help the mothers to prevent from early physical health problems and musculoskeletal pain. It is said to be cost effective. Also mothers handling children with disabilities need more awareness and motivation to engage them to do exercise [18]. In order to achieve a better quality of life and reduce the physical health burdens, it is important for mothers take regular medications and psychological counseling can also be a added on benefit in handling the disabled child.

CONCLUSION

Mother's handling cerebral palsy children, more commonly suffered with back pain, shoulder pain and knee pain comparing, especially those who handle level III, IV, V disability children. Awareness and early identification of these physical health problems and their management may improve quality of life of mothers and also will help in better handling of their children.

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Table 1. Physical Health Problems of Mothers

PHYSICAL HEALTH PROBLEMS OF MOTHERS	LEVEL I		LEVEL-II		LEVEL-III		LEVEL-IV		LEVEL-V	
	N	%	N	%	N	%	N	%	N	%
Neck pain	0	0	2	28.5%	4	40%	7	70%	10	58.8%
Back pain	1	100%	3	42.8%	10	100%	9	90%	15	88.2%
Shoulder pain	0	0	5	71.4%	6	60%	6	60%	12	70.5%
Upper limb pain	0	0	3	42.8%	7	70%	7	70%	10	58.8%
Hip pain	1	100%	1	14.2%	0	0	0	0	3	17.6%
Knee pain	0	0	1	14.2%	0	0	4	40%	11	64.7%
Ankle pain	0	0	0	0	0	0	0	0	0	0
Fatigue	0	0	2	28.5%	3	30%	8	80%	12	70.5%

N & % - Number of mothers & Percentage of mothers with physical health problems handling cerebral palsy children with various levels of disability.
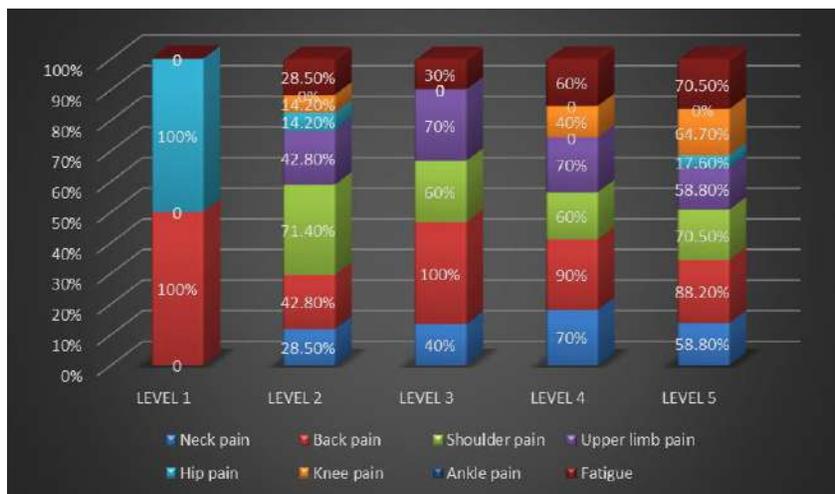
Fig. 1. Physical Health Problems of Mothers

RESEARCH ARTICLE

Status of Polluted Natural Water Bodies in India and Role of Government Agencies in Rehabilitation

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ABSTRACT

India is fortunate to have a diverse range of water bodies that support a substantial human population as well as wildlife, but they are constantly threatened by uncontrolled expansion of anthropogenic activities. Due to inadequate management of these water bodies, both the quality and quantity of their water have declined, and many of them have vanished. Industrialization, domestication, agricultural practices, urbanization, and other anthropogenic activities which are growing along with the population are to blame for the destruction of these water bodies. The most prevalent waterborne infections in India include typhoid, diarrhea, cholera, jaundice, dysentery, amoebiasis, dengue fever, and malaria. Each year, these water-borne illnesses kill thousands of people in India. Despite the fact that the government has built, enlarged, and modernized wastewater treatment facilities throughout the years, water pollution has remained a severe problem due to a lack of resources, public education and awareness. The Indian government has implemented multiple steps to minimize water pollution, and these efforts are being monitored but the problem is like as the same.

Keywords: Water bodies, pollution, Wastewater treatment, Government policies, Awareness drives.

INTRODUCTION

Water, soil, fire, sky, and air are essential to the survival of all living things. One of the "basic components" that we require to survive is water (Singh 2008)[1]. Rivers, lakes, glaciers, rainfall, groundwater, and other water supplies are essential in many economic sectors, including agriculture, forestry, industrial activity, hydropower generation,

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fisheries, animal rearing, and other creative endeavors (Tyagi et al., 2013) [2]. Freshwater makes up around 2.7 percent of all water on the planet, with 75.2 percent frozen in the polar regions and the remaining 22.6 percent available as groundwater. Freshwater may be found in rivers, lakes, and ponds, as well as in the temperature, humidity, soil boundaries, and vegetation. India possesses only 4% of the world's freshwater, although having about 18% of the world's population. The National Remote Sensing Center (NRSC) reported 6,35,661 water bodies in India(Standing committee on water resources, 2015-16)[3]. The Tata Institute of Social Sciences (TISS) claims that most large cities lack adequate water supplies. On the basis of origin Indian river drainage system is classified in to Peninsular Rivers and the Himalayan Rivers (Balasubramanian, 2007)[4]. Himalayan rivers are perennial and Peninsular rivers are seasonal.

Major cities in India are located along riverbanks .According to a report issued by the United Nations on March 22, 2010, World Water Day, 80% of urban garbage in the nation ends up in rivers, and the issue is getting worse because of unchecked urban development and lax government oversight (Garg, 2012)[5]. In India, over 2.6 billion people, or 40% of the world's population, lack access to basic sanitation, and more than a billion continue to consume tainted water (Pandey, 2006)[6]. More than 2.2 million people are estimated to pass away each year due to diseases brought on by tainted drinking water and inadequate sanitation (Bhat, 2014)[7]. The most prevalent waterborne infections in India include typhoid, diarrhea, cholera, jaundice, dysentery, amoebiasis, dengue fever, and malaria. According to research presented to the Lok Sabha on the instances and fatalities brought on by water-borne illnesses in India, between 2013 and 2017, the nation recorded 69.14 million cases of four water-borne illnesses. Other deadly diseases included viral hepatitis (2143), typhoid (2061), and cholera, which claimed 20 lives. Diarrhea claimed 6514 lives overall (Kumar and Tortajada, 2020)[8]. Many indicators, including dissolved oxygen (DO), biochemical oxygen demand (BOD), coliform organisms, pH, and others, can be used to detect and quantify water contamination in natural water bodies. Water quality standards state that BOD and DO levels in drinking water should be less than 2 mg/L and6 mg/L.

Importance of traditional water bodies in India

Inspite of drinking and bathing these water bodies are primarily accountable for a significant portion of India's GDP and jobs coming from tourism and seafood farming. Fish production increased significantly from 0.2 million tons in 1950–1951 to about 5.1 million tons in 2010–2011.Waterbody banks are crucial locations for animal reproduction and provide migrating birds with a habitat. In certain regions, endangered and threatened animal species can be found (Sahu, 2011)[9]. Boating, hunting, fishing, trapping, bird watching and many more outdoor activities available in these wetlands. Additionally, it has been noted that just taking pictures of wetland-dependent species draws around 50 million visitors annually who spend about $10 billion (Watershed management division 2015)[10]Excellent tourist attractions include the river system, waterfalls, scenic lakes, and springs. Tourism helps to promote the preservation of these natural resources (Sharma and Sharma, 2017)[11]

Sources of pollution in water bodies of India

Water is easily contaminated since it is the most ubiquitous solvent on the earth, capable of dissolving more compounds than any other liquid. Natural and artificial sources of pollution are both possible. Volcanic activity, forest fires, seepage from rocks into the water are some examples of natural sources of pollution. Many anthropogenic or artificial sources come from home and industrial garbage they may be direct and indirect sources of pollution. The effluent outfalls of factories, refineries, and other businesses, which release fluids of varying qualities into water bodies, are direct sources of water contamination. Indirect sources of water contamination include pollutants that enter the water supply through soil/groundwater systems and the environment through precipitation. In soils and groundwater exist residues from human agricultural activities like fertilizers, pesticides and improperly disposed of industrial waste (CPCB,2016)[12].

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Industrialization

Petroleum hydrocarbons, chlorinated hydrocarbons, different acids, alkalis, heavy metals, dyes, detergents, and other dangerous compounds are only a few of the pollutants found in industrial wastes, all of which drastically affect the pH of water. These substances are harmful to living things found in water bodies and can kill them (Kumar, 1996)[13]. In comparison to other industries, distilleries, the textile and paper industries have a greater impact on water bodies. Previously used as sources of drinking water, Hyderabad's Osmansager and Himayatsagar lakes are now filled with poisonous effluents produced by nearby factories (Ramachandraiahet al., 2004)[14].

Urbanization

Urbanization has been highlighted as one of the most significant factors contributing to the extinction and destruction of these water systems. India, like other developing nations, has been going through this shift from old rural economies to modern industrial economies, which is measured by urbanization (Datta, 2006)[15]. According to an examination of census data from 2011, urbanization has grown by 31.8% in India over the past ten years, which is a significant role in the deterioration and extinction of water bodies (Kang, 2013)[16].

Agricultural Practices

Eutrophication of water bodies is caused by farming activities, such as the use of nitrogen and phosphorus fertilizers and their run-off (Sugam et al.,2018)[17]. Lonar Lake, located in Maharashtra's Buldhana district and dubbed the world's third-largest natural saltwater lake, is suffering from cultural eutrophication as a result of toxic chemicals such as inorganic fertilizers, pesticides, and insecticides accumulating along with the runoff of the river (Yannawar, 2013)[18].

Domestication

Untreated sewage discharge is India's biggest source of water pollution. Sewage was listed as a highly polluting source by the Indian Planning Commission in its Tenth Plan Document, accounting for almost 80% of all water contamination (Malik and Biswas, 2013)[19]. The highest concentration of perflu or ooctanoic acid (PFOA), which was discovered in untreated sewage samples, was found to be 3.1 ng L^{-1}, according to a survey the Ganges River dolphin was estimated to have 27.9 $ng^{g-1}ww$ of perfluoro octane sulfonic acid (PFOS) in it (Yeung et al., 2009)[20].

Pollution due to Religious and social values of water bodies in India

Unburned corpses are dumped into the river after being incinerated on the riverbanks. Because of the Hindu belief that cremation of the deceased allows them to reach salvation, this problem is specific to Varanasi. Because of this, the river receives about 15,000 tonnes of ash each month. The large people populations that the mass bathing activities bring to the river's edge have a significant negative impact on both the ecosystem of the river and the health of those who participate owing to the exposure to a variety of health issues (Sridhar et al., 2015[21]; Verma et al.,2022[22]).

Degradation of quantity and quality of the water bodies in India

Any direct or indirect alteration of the physical, thermal, chemical, biological, or radioactive properties of any components of the environment by, discharge, emission, or deposit of wastes in such a manner as to adversely affect public health, animals, birds, ecosystems, aquatic life and plants. Due to the concurrent rise of human activity along rivers, water sources have become more and more hazardously polluted in recent decades (Alam et al., 2009)[23]. As a result of human activities like farming, mining, industries, or urban development, a lot of heavy metals are produced and discharged into the aquatic environment. They are subsequently deposited in sediments, where the food chain biomagnifies them (Yi et al., 2011)[24]. Many of the factories that line the river's bank discharge untreated wastewater into it. The deteriorating condition is explained by the fact that the once-seasonal river transporting freshwater has changed into a perennial river carrying large amounts of sewage and effluents (Kang and Seth, 2012)[25]. According to a report, pesticides (DDT and HCH) were discovered in considerable concentrations in freshwater systems, bottled drinking mineral water samples, and some rural regions in Delhi, Bhopal, and other

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towns (Agrawal et al., 2010)[26]. Although heavy metals are still prevalent in the aquatic environment, several preventative measures are being employed to reduce the flow of heavy metals into the water system (Dural and Bickici 2010 [27]; Khound and Bhattacharyya 2017[28]).Water quality monitoring data shows that the water quality is low at several monitoring points along Indian rivers. There is also a lot of anecdotal evidence of high levels of pollution in Indian rivers, especially in the more developed states and near big cities. India generates 29 billion liters of wastewater every day but only collects and treats 6 billion liters of water. Although 1,20,000 tons of municipal solid waste are produced every day, only 70% of it is collected and only 5% is treated (Sengupta,2007)[29]. Approximately 2,277 lakh people reside in the 498 Class I cities in India. They generate about 35,558 MLD of wastewater, of which about 11553 MLD, or roughly 32%, gets processed (CPCB 2009-10)[32]. In 410 towns in India's Class II cities, there are around 300 lakh residents. Only 234 MLD (or 8.6%) of the 2696 MLD of wastewater they produce is treated (CPCB 2009-10)[30]. Although treatment capacity only increased from 2,758 MLD to 23,277 MLD, sewage generation surged from 7,067 MLD in 1978–1979 to 62,000 MLD in 2014–15. (CPCB, 2021)[31]. Sewage generation from urban centers is expected to be 72,368 MLD, and there are 1,631 STPs (including proposed STPs) with a total capacity of 36,668 MLD encompassing 35 States/UTs in India. Considering such a gap of untreated sewage, the remaining amount is sewage. 75% of India's surface water bodies have been contaminated by the discharge of untreated wastewater (CPHEEO, 2012)[32].

Status of water bodies pollution in India

Ganga River

Thousands of fishes and other aquatic life forms have died as a result of the increased amount of excess water pollution in the Ganga River. Kanpur's 19 sewers discharge untreated sewage into the Ganges right away. Wastewater from tanneries is the main cause of Ganga River contamination in Kanpur. The recent statewide lockdown in India from March 25 to April 14, 2020, because of COVID-19, has resulted in an improvement in the clarity of the Ganga River's water quality. Due to the lockdown, where people have stayed at home and businesses have closed, it was found that the dissolved oxygen level rose by 25–30% while the biochemical o oxygen demand level fell by 35–40%(Singhetal.,2020)[33]. Uttar Pradesh generated great amount of waste water through a very high number of industry discharge in compare to other cities while Jharkhand have no industries along the river sides so no waste water generation in ganga river.

Yamuna river

According to data, the Yamuna River has become one of the most polluted rivers in India and the globe. The Yamuna River is the largest tributary of the Ganga. It originates near Bandar Punch in Mussourie, Uttarakhand, from the Yamunotri glacier. Delhi's entire household and industrial rubbish output contributes the most to Yamuna River pollution, followed by Agra and Mathura. The river water is in the CPCB category E. Sharma et al., 2020 study the Yamuna River's water contamination using physicochemical parameters. The fact that total coliform, temperature, and hardness are all increasing is alarming (Sharma et al., 2020)[34]. The Yamuna has been reduced to a little stream that discharges sewage, dirt, and other contaminants as well as industrial effluents, to minimize pollution levels, quick dramatic action is required (Mishra, 2010)[35]. It is not advised to drink the river water because the heavy metal pollution index (which ranges from 98.2 to 555.1) classified almost 85% of it as highly dangerous (Asim and Rao, 2021)[36]. The contamination of the Yamuna River in Dehradun has been blamed on tourism, bad sewage systems, and a lack of waste water management services.

Kasardi River It was discovered that the majority of these harmful heavy metal concentrations were substantially higher than the maximum allowable limits in the study of the Kasardi River, which gets a heavy discharge of waste effluent from the near by Taloja industrial zone of Mumbai (Lokhande et al, 2011)[37].

Gomti River

The Gomti River is a holy river that flows from Gomat Taal near Madho Tanda in Pilbhit, India. An investigation revealed that the Gomti River's water was highly contaminated with organic waste. In several of the areas, the Dissolved Oxygen (DO) level was nil. The average minimum DO value recorded was 0.95 mg/l. The river water is

perilous for any home use, including bathing, as it exceeded the CPCB's authorized standard of Biochemical Oxygen Demand (3.35-18.93 mg/l) (Singh et al., 2005)[38]. According to an analysis of river's water quality with several physicochemical parameters, the water was unfit for human consumption, and that some sites had extremely high heavy metal limits (Singh et al.,2016)[39].

Mahanadi River system is the largest in the state of Odisha. The water in the basin's downstream regions has been contaminated by sewage deposited from Cuttack and Sambalpur, making it unfit for potable and agriculture. Sulphate concentrations (as high as 360.50 mg/l) were found to be far beyond the acceptable limit for domestic use (Sundaray et al., 2009)[40].

Cauvery River is one of the most important rivers in Karnataka and Tamil Nadu. It originates in Talakaveri, Kodagu, Western Ghat, Karnataka and flows into the Bay of Bengal. Vijayalaksmi et al. (2013)[41] assessed the water quality of the Cauvery River and reviewed the findings using physicochemical parameters and microbiological populations, and determined that the levels of the parameters were greater than the standard value. All human activities, such as sewage, industrial waste, and agricultural runoff, release various chemicals into the Cauvery River, polluting the river.

Damodar River also known as sorrow of Bangal originated from Chota Nagpur Plateau. Banerjee and Ghosh (2012)[42] assessed the water quality of the river, the samples were collected from seven different locations and tested for parameters such as pH, EC, TDS, DO, BOD, Pb, Fe, SO_4 2-, and so on. They determined that greater heavy metal concentrations and BOD levels indicated a significant organic load.

River Hindon offers a considerable quantity of water to the densely populated and mostly rural population of western Uttar Pradesh. Water pollution indicated that Hindon's water quality was relatively bad in terms of its suitability for residential use, with criteria several times higher than the CPCB permissible limit. (Suthar et al.,2010)[43].

River Kolong's water quality index (WQI) score of 122.47 during the monsoon season indicates extremely low, unsatisfactory water quality. In one of their assessments, the CPCB identified the Kolong River as one of the most contaminated rivers in India. (Bora and Goswami, 2017)[44].

Indus, Beas, and Sutlej Rivers
Multivariate statistical methods were used to examine data on the heavy-metal condition of the Indus, Beas, and Sutlej Rivers, as well as the Harike Wetland, from 2013 to 2017. The Sutlej River and the Harike Wetland were found to be severely polluted with heavy metals because of the population's rapid increase and quick industrialization (Kumar et al.,2018)[45].Sutlej River is Punjab's longest river. The city's untreated sewage and industrial wastes are dumped into the river. The WQI performed at numerous river places demonstrates that the water quality is unfit for human consumption (Sharma et al., 2018)[46].

Hooghly River Khumanet al. (2019) investigated the distribution of pesticide persistent organic pollutants in the Hooghly River. They documented widespread use of organo chlorine pesticides (OCPs) such as Endosulfan, DDT and HCH (Khumanet al., 2019)[47].

Ramganga River
Ramganga flows from the Dudhatoli hills in Uttarakhand's Chamoli district. Physicochemical measures were used to analyses the water quality of the Ramganga River. The findings of the entire examination revealed that the Ramganga River's water quality was fairly poor. They discovered that the BOD, COD, and phosphorus levels were over the WHO and BIS allowed limits (Gupta et al.,2016)[48].

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Dravyavati river, which serves as the primary drainage channel of Jaipur, Rajasthan, has increased by 75% in sewage and sludge content, with heavy metals (Fe, Mn, and Zn) levels above WHO standards (Rajput et al., 2017)[49].

Lake Ukkadam Sediments in Coimbatore were found to have concentrations of Hg and Cu of 5.08 mg/kg dry weight and 203.32 mg/kg dry weight, respectively (Shivalingamet al., 2021)[50].

Nainital Lake
Heavy metal concentrations in Nainital Lake are rising as a result of increased human activity and modern agricultural methods. Because the lake is the community's sole source of drinking water, heavy metals have the greatest potential to harm aquatic life by entering the food chain. (Malik and Biswas, 2013)[51].

Chilika Lake's sediments are rich in heavy metals (Pb, Ni, Cr, Cu, and Co), with a high concentration of lead (Pb) indicating a potential biological concern (Barik et al.,2018)[52].
In **Mansagar Lake**, Jaipur, COD climbed to 500 mg/l during the rainy season due to an increase in metal content, when it was only 200 mg/l before the wet season. Peak summer and late winter seasons have been found to have higher levels of pollutants (Sing and Jain, 2021)[53].

Acts, Policies and Awareness drives for the rehabilitation of water bodies in India by the Government
In many areas of India, large stretches of rivers lack the flows necessary to support marine ecology, cultural requirements, and aesthetics and are badly polluted by untreated industrial effluents and urban garbage. India had to take various measures to preserve water bodies due to the country's increasing water shortage, declining water quality, and poor management (Kumar and Bharat, 2014)[54]. The Government of India is running several programs to preserve natural water bodies. According to the Rural Development Ministry, the Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGS), the government's most well-known rural employment guarantee program, is being reoriented toward water conservation to boost water storage and agricultural activities in India (Hindustan Times, Jul 02, 2019)[55].To revive and restore fading water bodies that have significantly reduced irrigation capacity, the Government of India initiated the Repair, Renovation, and Restoration (RRR) of Water Bodie's scheme. After a successful pilot run, a full-scale version of the plan was implemented during the XI Plan. Due to the benefits associated with its implementation, the system was also implemented in the XII Plan. The National Wetland Conservation Programme (NWCP) was established by the Ministry of Environment, Forestry and Climate Change (MoEF and CC) in 1987 to conserve the country's identified wetlands, preventing their destruction, and ensuring their wise use for the benefit of local communities and the preservation of biodiversity as a whole. Under the National Lake Management Plan, the MoEF and CC are also supporting the States in their efforts to conserve and restore contaminated and damaged lakes in urban and semi-urban areas of the world (NLCP). In situ lake cleaning procedures including de-weeding, de-silting, bio-remediation, artificial wetland approach, etc. are included in the NLCP. These actions include the prevention of pollution from point sources by intercepting, redirecting, and treating the pollution load entering the lake.

The Ministry of Telangana began a program called "Mission Kakatiya" in 2014-15 to repair 46,531 water bodies. In June 2015, The Atal Mission for Rejuvenation and Urban Transformation (AMRUT)[56] was established to provide urban services such as sewerage/septage, water supply, irrigation, green space and parks, urban transportation, and water body rejuvenation, specifically for drinking water supply and groundwater recharge. India has been an active member of the United Nations and is dedicated to the UN's 2015 Sustainable Development Goals (SDGs). Under SDGs 6 and 11, India aspires to improve its water bodies, and water quality, and deliver a holistic sustainable solution (Bais et al., 2020)[57]. SDG6 ensures that by 2030, everyone has access to safe and clean drinking water, improves water quality by lowering emissions, eliminating dumping, limiting the release of hazardous chemicals and products, and considerably expanding global recycling and safe reuse. Among these programs is the National Rural Drinking Water Program (NRDWP), the Accelerated Urban Water Supply Program (AUWSP), Namame-Gange (National Mission for Clean Ganga), and the National Water Policy. The National Mission for Clean Ganga (NMCG) would have completed 22 projects and approved 17 new ones by 2020, totaling Rs. 557.83 crores in the

fields of Sewerage Infrastructure, Ghats and Crematoria, Afforestation, Pollution Abatement, Biodiversity, and others (MJS, 2020)[58].

The Water (Prevention and Control of Pollution) Act of 1974
The Central and State Pollution Control Boards (the CPCB and SPCBs) were established by the Water (Prevention and Control of Pollution) Act to oversee, offer guidelines and standards, and carry out rules relating to the treatment and disposal of sewage and trade effluents.

The 2012 National Water Policy
Water allocation (drinking, irrigation, hydropower, navigation, commercial, and other uses), conservation, and conjunctive use are all prioritized in the NWP. It focuses on water conservation, recycling, and reuse, as well as water demand management, sectoral water use quality, sanitation, water supply and increasing water availability.

The Environmental (Protection) Act 1986
The Central Government was given the authority to establish guiding principles to reduce environmental pollution under this Act. The environmental regulations set criteria for the quality of surface water for a variety of uses (irrigation, domestic, industrial, recreational, etc.).

National Water Quality Monitoring Programme (NWMP)
As part of the National Water Quality Monitoring Program, the CPCB tracks 2021 locations on Rivers, 608locations on Lakes/ Ponds/ Tanks, 63 locations on Creeks/Seawater/marine water, 65locations on Canals, 60 locations on Drains, 56 locations on Sewage Treatment Plants, 5locations on Water Treatment Plants (Raw Water), and 1233 on wells. Under NWMP 36Real-Time Water Quality Monitoring Stations were installed in River Ganga (CPCB19-20)[59].

National Plan for Conservation of Aquatic Eco-systems (NPCA)
Scheme backed by the government is implemented in February 2013 under the Ministry of Environment, Forest and Climate Change for the conservation of wetlands and lakes, lakefront development and beautification in urban lakes.

Ganga Action Plan I(GAPI)
The World Bank Board of Directors approved the Second National Ganga River Basin Project (Ganga–II) for US$ 400 million on June 25, 2020. (Rs. 3023.10 crores).On July 7, 2020, the World Bank and India's Department of Economic Affairs signed aloan agreement(MJS, 2020)[58].

The Namami Gange program was launched in 2014 by the government of India to clean the Ganga River and a budget of Rs20,000 crore was allocated for 2015-2020. There are 8 Common Effluent Treatment Plants (CETPs) and 105 Sewage Treatment Plants (STPs) located on the banks of the river Ganga.

The Yamuna Action Plan (YAP Phase-I) was initiated in 1993 by the Government of India with the assistance of the Government of Japan, to improve river water quality to the required bathing standard. This plan was implemented under the name Yamuna action plan II (YAP Phase-II) from 2000 to 2002. In 2017, the 'Maily Se Nirmal Yamuna' Revitalization Plan 2017 Phase-I was implemented, with the Finance Ministry allocating roughly Rs 344 crores for the construction of STPs in the Najafgarh Drain (PIB report, 2017)[60].

Atal Mission for Rejuvenation and Urban Transformation (AMRUT) Ministry of Housing and Urban Affairs, Government of India started in 2015, The Mission will focus on water supply, Sewerage and sep tage management, non-motorized urban transport, storm water drainage tore duce flooding and increase green space/parks.

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National River Conservation Plan (NRCP) was launched in 1995, The GAP Phase II program was linked with the National River Conservation Plan (NRCP) in 1996, integrating all river-cleaning initiatives across the country under the NRCP's umbrella scheme. Presently NRCP covered polluted stretches of 33 rivers. The projects "Assessment of the ecological status of select 6 Indian rivers (namely Mahanadi, Cauvery, Godavari, Periyar, Narmada, and Barak River)" and "A project to enhance and restore the river Rani Chu in Zone-I, Gangtok, Sikkim" have been approved for a total of Rs.95.36 crore under the NRCP by the wildlife institute of India (WII), Dehradun (MJS,2020)[58]. According to STANDING COMMITTEE ON WATER RESOURCES (2015-16), the Jalmanthan and 'India Water Week awareness program has been organized by the Ministry of Water Resources, River Development and Ganga Rejuvenation to spread awareness for the protection and maintenance of water bodies.

The National Water Quality Sub Mission (NWQSM) was initiated by the Indian government to improve the quality of drinking water in areas where people are forced to drink polluted water. The Indian government initiated Swajal, a community-led drinking water initiative, in March 2018 (Ahmed and Araral,2019)[61]. To encourage all stakeholders to construct Rain Water Harvesting Structures (RWHS) that are suitable for climatic conditions the National Water Mission launched the "Catch the Rain" campaign with the tagline "Catch the Rain - when it falls, where it falls" (MJS, 2020)[58]. On November 14, 2019, the National Water Mission launched the "SahiFasal" campaign to encourage farmers in water-stressed areas to grow crops that are not water-intensive but use water efficiently (MJS,2020)[58].The state government of Rajasthan launched the campaign 'Jal Chetna' in 2006 through public participation, focusing primarily on de-silting and sediment excavation to improve the reservoir's potential for water retention by which Budha Lake in Ajmer benefitted (Sharma et al.,2009)[62]. The Government of Rajasthan initiated the Mukhyamantri Jal swavlamban Abhiyan ('water self-reliance mission') in 2016 in 295 Blocks across 33 districts to establish a water-sustainable Rajasthan.

CONCLUSION

According to the study, the bulk of India's water sources are highly contaminated and provide a threat to human health. To address the complicated water scenario that exists today, which is characterized by scarcity and the depletion of this renewable but limited resource, India's water legislation continues to be inconsistent, contradictory, and ineffectual. The amount of sewage predicted to be generated is 72,368 MLD, but only 20,235 MLD of the available capacity has been used, leaving 52,133 MLD of untreated sewage. Realizing sewage as a resource will enable less raw water to be used, which will help preserve natural water supplies. Non-potable uses for treated sewage include irrigation, horticulture, toilet flushing, firefighting, non-contact impoundments, washing of floors, roads, trains, and buses, and industrial utilities. The use of bio-fertilizers rather than chemical fertilizers should be encouraged. Domestic and industrial wastewater should be adequately managed in wastewater treatment facilities before being released into natural aquatic habitats. The best preventative measures involve managing farm run-off and avoiding the dumping of home and industrial effluents. Despite environmental policy legislation and constitutional provisions for environmental protection, our country faces a severe problem with industrial waste disposal, which pollutes natural resources at all hours of the day and night. It is important to strictly enforce the laws governing water treatment. No solid garbage should ever be dumped into waterways. Depending on the quantity, concentration, toxicity, and presence of non-biodegradable organics in the effluents, industries may employ one or more of the following processes for the treatment of industrial wastewater: volume reduction, strength reduction, neutralization, equalization, and proportion; removal of suspended solids, colloidal solids, inorganic dissolved solids, and organic dissolved solids. So, rather than treating with expensive treatment systems, it is necessary to strengthen the capacity of water pollution treatment and raise public awareness of the need to improve water quality and prevent water pollution. The river sites should be cleaned using bioremediation and phytore mediation technologies.

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Table 01: Comparative statistics on the national inventory of sewage treatment plants for years 2014 and 2020.

S.No.	STP Status	2014		2020	
		No. of STPs	Capacity (MLD)	No. of STPs	Capacity (MLD)
1.	Operational	522	18883	1093	26869
2.	Nonoperational	79	1237	102	1406
3.	Under construction	145	2528	274	53566
4.	Proposed	70	628	162	4827

Source: Central Pollution Control Board, 2021

Table 02: State-wise status of industrial unit, water consumption, and wastewater generation in Ganga River.

States	No. of industries	Water consumption (MLD)	wastewater generation (MLD)
Uttrakhand	42	224	127
Uttar Pradesh	687	693	269
Bihar	13	91	17
Jharkhand	-	-	-
West Bengal	22	116	88
Total	764	1124	501

Source: CPCB 2013
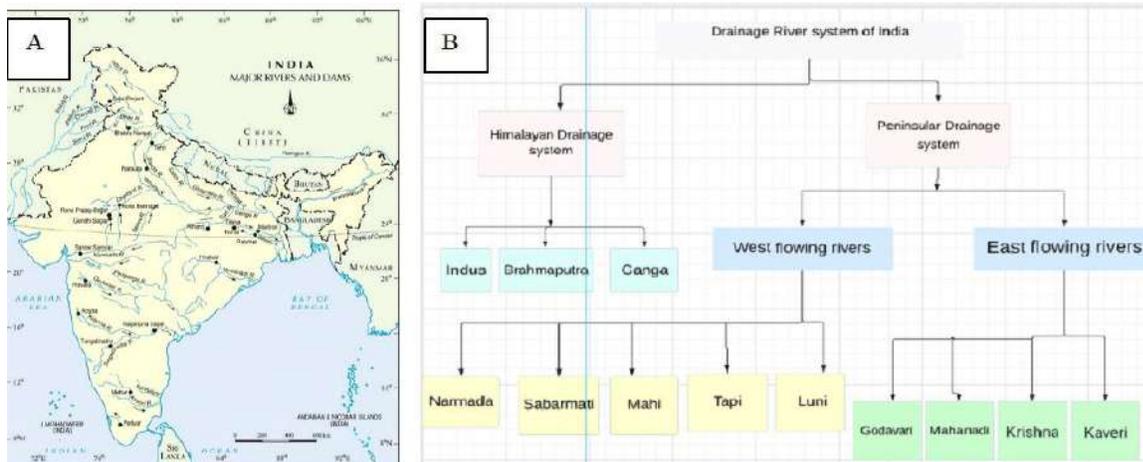
Figure 1, Indian River System: A shows Indian Rivers on map and B shows drainage system of Indian Rivers.

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RESEARCH ARTICLE

Effect of Gibberellic Acid (GA₃) Seed Priming on Seed Germination and Early Seedling Growth of Salt Stressed *Majidea zangueberica, Phyllanthus emblica, Tectona grandis* and *Tabebuia aurea*

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ABSTRACT

One of the plant growth regulators, gibberellic acid (GA₃), helps plants tolerate salt efficiently and minimizes the effects of salt stress. The current study aimed to determine the effect of GA₃ on seed germination and physiological parameters of four seeds: *Majidea zangueberica* Kirk ex oliv., *Phyllanthus emblica* L., *Tectona grandis* L. f. and *Tabebuia aurea* (Silva Manso) Benth. & Hook. f. ex S. Moore, under different salt concentrations. The experiment was conducted using a factorial design with a completely randomized block design and three replicates. Two levels of salinity (50 mM and 100 mM NaCl) and two hormone conditions (GA₃ at 150 ppm versus without GA₃) were the experimental conditions. When the salt level was 50mM NaCl, priming the seeds of these tree species with 150 ppm of GA₃ significantly increased the germination percentage, decreased mean germination time, increased shoot and root length and raised the total weight of the seeds ($P<0.05$).

Keywords: Salt priming, tolerance, Germination percentage, Gibberellic acid, Shoot and root length.

INTRODUCTION

Salinity, induced by a higher concentration of salt in the soil, significantly affects a substantial portion of plants. This issue is particularly pronounced in regions with hot and dry conditions, and it stands as one of the most serious obstacles impeding crop germination and productivity [1;2]. The adverse effects of elevated soil salinity levels, resulting from a combination of high osmotic potential and unique ion toxicity, greatly impact both the quality and quantity of plant production. These effects lead to the suppression of seed germination, seedling growth, and developmental phases [3;4]. Notably, the germination percentage, shoot and root length, as well as the fresh weight of the shoot and root, all exhibit abnormalities attributed to the higher salt concentration. Plants encounter two fundamental challenges in saline environments. First, the soil contains a significant amount of salt, which diminishes the osmotic potential of the soil solution, thereby reducing water absorption by plants and inducing a water deficit. Furthermore, the increased absorption of Na^+ and Cl^- ions results in plant deficit. Furthermore, the increased absorption of Na^+ and Cl^- ions results in plant toxicity, preventing the essential uptake of vital nutrients [5;6]. Plant growth regulators, such as GA_3, are highly effective in stimulating and optimizing germination, plant development, and photosynthetic activity. This is attributed to their ability to trigger numerous physiological responses in plants [7]. In saline conditions, patterns of growth reduction can emerge. However, these patterns can be mitigated by the progressive efficacy of exogenous GA_3 application, which influences various morphological, physiological, and biochemical activities in plants. The utilization of GA_3 is particularly helpful in reducing saline stress, with its effectiveness being more pronounced in salt-resistant cultivars [8]. Gibberellic acid contributes to the alleviation of the deleterious effects of salinity to a certain extent by enhancing vigor, antioxidative enzyme activity, and the accumulation of osmolytes. Furthermore, GA_3 treatment facilitates the production of hydrolytic enzymes, which are essential for breaking down endospermic starch as seeds initiate growth during germination [9; 10] Hence, the objective of the present study is to comprehend the germination activity and seedling growth achieved through priming with GA_3 in seeds of *Majidea zangueberica* Kirk ex oliv., *Phyllanthus emblica* L., *Tectona grandis* L.f. and *Tabebuia aurea* (Silva Manso) Benth. & Hook. f. ex S. Moore. Additionally, the seeds were subjected to NaCl treatment to assess their tolerance capacity during both germination and the early seedling growth phases.

MATERIALS AND METHODS

Seed collection

Mature seeds of *Majidea zangueberica* Kirk ex oliv. (Sapindaceae), *Phyllanthus emblica* L. (Phyllanthaceae), *Tectona grandis* L.f. (Lamiaceae) and *Tabebuia aurea* (Silva Manso) Benth. & Hook. f. ex S. Moore (Bignoniaceae) were collected between September and December 2020 from the Western Ghats, Sadivayal area in the Coimbatore district (11.0168° N, 76.9558° E). The collection site experiences an average annual temperature of 26°C, varying from 32°C in September to 19°C in December. Several hundred seeds were gathered from 10 randomly selected trees within a 20-km radius by gently shaking the mature trees. Subsequently, the seeds were transported to the laboratory on the same day. Upon arrival, they were visually examined and any damaged or unhealthy seeds, as well as debris, were meticulously removed. The seed surface underwent sterilization using a 5% sodium hypochlorite solution for a duration of 10 minutes, followed by thorough rinsing with sterile distilled water for 4 to 5 cycles. Afterward, the seeds were air-dried on a bench for a day before being stored in airtight glass bottles under room temperature and humidity conditions, remaining preserved until their utilization in the experiment.

Hormonal priming

The seeds were subjected to priming by immersing them in a 150 ppm GA_3 solution for a duration of 12 hours at 27°C, all conducted in complete darkness. This was achieved by enveloping the Petri dishes with two layers of aluminium foil paper to ensure an absence of light. After the priming process, the seeds were taken out and cleansed under running tap water, followed by three rinses using sterile distilled water. The cleansed seeds were then gently dried by being placed between filter papers. Upon completion of the drying step, the seeds were positioned within

Petri dishes containing moist no.1 What man filter paper. These Petri dishes were maintained under room conditions at a temperature of 27°C. As for the control group, the seeds (which were not subjected to priming) were soaked in water for a span of 12 hours, subsequently dried once again, and then arranged in Petri dishes with moist No.1 What man filter paper, all under the same room conditions at 27°C. A fully randomized factorial experiment was conducted, encompassing three replicates of 25 seeds each for both the control, salt treated and primed with salt treated groups(seed with 50mM Nacl and seed with 100mM Nacl). These groups were subjected to equal volumes of NaCl solutions at two distinct concentrations: 50mM and 100 mM..Various physiological parameters, including seed germination percentage and mean germination time, were determined using the following formulas. The lengths of both shoot and root of all seedlings were gauged utilizing a transparent ruler. Additionally, the fresh weights of the seedlings were measured using a weighing balance. For further analysis, the seedlings were subjected to drying at 70°C for a duration of 12 hours, after which their dry weights were recorded [11;12].

Measurements of germination efficiency
Total germination (TG) was measured every day and terminated at day 14 after sowing (Kandil et al. 2012). It was computed as:

TG% $=\frac{n}{N}$ ×100, Where n is the total germinated seeds, and N is the total seeds sown.

Mean germination time (MGT) was calculated according to[13]

MGT$=\frac{\sum(n \times d)}{N}$

where n = number of seeds germinated on each day,
      d = number of days from the beginning of the test, and
      N = total number of seeds germinated at the termination of the experiment

The Vigour index (VI) was measured using the formula of [14]
 VI= TG% × Seedling Length (cm)/100

Statistical analysis
All experiments were carried out in triplicates and results are expressed as mean ± SE (n=3). To analyse the differences among mean values of different treatments one-way analysis of variance (ANOVA) was conducted. The data were analyzed using SPSS (2.0) software.

RESULTS

Seeds of *Majidea zangueberica* Kirk ex oliv., *Phyllanthus emblica* L., *Tectona grandis* L.f. and *Tabebuia aurea* (Silva Manso) Benth. & Hook. f. ex S. Moore. were sown and irrigated with different concentrations of saline solutions, and the outcomes of the study were collected by determining various germination and seedling growth parameters.

Germination Percentage and Mean Germination Time of the four Seeds
The analysis of variance revealed significant effects of both salinity and priming with GA₃ on the germination percentage and mean germination time of *Majidea zangueberica, Phyllanthus emblica, Tectona grandis* and *Tabebuia aurea* (P <0.05) (Table 1). Among these species, at the salinity level of 50 mM NaCl, the germination percentage was highest in Samanea saman, followed by *Phyllanthus emblica* (33.00± 0.58), *Tectona grandis* (30.00 ± 0.58), *Majidea zangueberica* (23.33 ± 0.88) where as the *Tabebuia aurea* exhibited the lowest percentage (22.33 ± 0.88). Notably, germination was significantly more successful up to the 50mM NaCl salinity level in the primed seeds compared to the 100 mM NaCl level. When seeds with the treatment of NaCl level without GA₃ showed germination percentage were less when compared with primed group. Seed germination is pivotal and critical phase within the plant life cycle, significantly influencing plant establishment and overall productivity. This process can be impeded by various abiotic stresses, with salt stress posing distinct challenges. Recent research corroborates earlier findings [15] suggesting that plants employ the accumulation of specific inorganic ions or organic compounds to regulate osmotic potential. This serves as a strategy to counteract the initial impediments posed by salinity, aiding in the maintenance of appropriate ion concentrations in the soil solution. Consequently, this adaptive mechanism helps safeguard

against compromised water uptake by the roots, thus enabling efficient seedling establishment in saline environments [16]. Interestingly, when seeds were sown under differing salt levels, the pace of germination and the duration required for germination displayed a direct correlation. Remarkably, the priming of seeds with a 150ppm GA$_3$ solution enhanced the response of seed germination of salinity.   This observation resonates with existing reports, suggesting that GA$_3$ positively impacts germination percentage and mitigates the adverse consequences of salinity-induced stress on germination. T1- 50mM NaCl; T2-100mM NaCl; T3- GA3+50mM NaCl; T4- GA3+100mM NaCl; T5-Control [#]Each value is a mean of five replicates ±SE (standard error). This means that a column followed by the same superscript (P>0.05) differs according to Duncan's multiple range test.***, * at P<0.001 and P<0.05 respectively.

Effect of Salinity and Priming on the Seedling Growth Performance of the four seeds

Elevated levels of salt exposure exert stress on seeds, leading to a decrease in various experimental seedling parameters, including shoot and root lengths, shoot and root fresh and dry weights, as well as seedling vigor index. The growth of seedlings displays an inverse correlation with the intensity of salinity conditions. It is evident that seedling development experiences a significant decline as saline levels increase.   However, the application of priming with GA3 induces a stimulating effect on maximal physiological characteristics, particularly up to a salinity threshold of 50mM NaCl. Comparatively, lower rates of seedling performance (14%) were observed in non-primed seedlings subjected to saline water levels ranging from 50mM to 100 mM NaCl for *Majidea zangueberica*. This was followed by *Tectona grandis* (25%), *Phyllanthus emblica* (24%), and *Tabebuia aurea*(39%). In contrast, a significantly higher proportion of seedling performances (65%) were documented in primed seedling irrigated with salinity levels up to 50mM NaCl for *Tabebuia aurea*. This was followed by *Phyllanthus emblica* (54%), Tectona grandis(47%), and *Majidea zangueberica* (33%). The growth of seedlings belonging to *Majidea zangueberica*, *Phyllanthus emblica*, *Tectona grandis* and *Tabebuia aurea* exhibited significant reduction when cultivated under high saline conditions. Seedling vigor experienced a substantial decline from the control (absence of salt, GA$_3$) to the 50mM NaCl concentration. The highest seedling vigor index was observed at 50mM NaCl (1.20 to 4.56), whereas the lowest seedling vigor index was recorded at 100 mM NaCl (0.58 to 3.28). These results have been documented in tables. Consequently, these declines in seedling performance were consistent across all tested parameters, including shoot length, root length and seedling fresh and dry weight as illustrated in tables 1 & 2.

Extensive documentation supports the notion that the influences of the growth medium on salinity-induced effects results in reduced seedling characteristics among seeds as salinity levels escalate. Furthermore, it has been observed that GA$_3$'s capacity to counteract this effects diminishes as the stress reaches its peak, particularly evident at the highest salinity level (100 mM NaCl) The application of 50mM NaCl concentrations to primed seeds exerted a significant stimulatory effect on shoot and root growth in *Phyllanthus emblica, Tectona grandis*, and *Tabebuia aurea*. However, it led to a reduction in root growth for *Majidea zangueberica* both at 50mM and 100 mM NaCl concentrations. Notably, at the higher 100 mM NaCl concentration, the shoot and root lengths of all four seed types were significantly decreased. All salt treatment and control groups shows the reduction in shoot and root growth. In specific terms, *Majidea zangueberica* exhibited the highest reduction in both shoot and root length, with reductions of 8.41% (primed) 4.40% (unprimed) for shoot length, and 5.46% (primed) and 2.325 (unprimed) for root length a the 100 mM NaCl concentration. On the other hand, *Tabebuia aurea* show cased the lowest reduction, with a decrease of 25.22% (primed) and 10.75% (unprimed) for shoot length, and 16.03% (primed) and 8.11% (unprimed) for root length, respectively, at the 50mM NaCl concentration whereas the salt treatment 9.12 -15.22%. At the 50mM NaCl concentration, the highest average total fresh and dry weights were observed (see figures 1 to 3), indicating robust seedling development. Conversely, at the higher salinity level of 100 mM NaCl, there was a lesser discrepancy recorded for the total dry weight of the seedlings. In this context of 50mM NaCl, the primed seeds of *Tabebuia aurea* exhibited a more significant reduction (primed: 4.32, unprimed: 0.32), where as *Majidea zangueberica* displayed a comparatively minor reduction (primed: 2.31, unprimed: 0.24).

DISCUSSION

Germination Percentage and Mean Germination Time of the four Seeds

Seed germination is pivotal and critical phase within the plant life cycle, significantly influencing plant establishment and overall productivity. This process can be impeded by various abiotic stresses, with salt stress posing distinct challenges. Recent research corroborates earlier findings [15] suggesting that plants employ the accumulation of specific inorganic ions or organic compounds to regulate osmotic potential. This serves as a strategy to counteract the initial impediments posed by salinity, aiding in the maintenance of appropriate ion concentrations in the soil solution. Consequently, this adaptive mechanism helps safeguard against compromised water uptake by the roots, thus enabling efficient seedling establishment in saline environments [16]. Interestingly, when seeds were sown under differing salt levels, the pace of germination and the duration required for germination displayed a direct correlation. Remarkably, the priming of seeds with a 150ppm GA_3 solution enhanced the response of seed germination of salinity. This observation resonates with existing reports, suggesting that GA_3 positively impacts germination percentage and mitigates the adverse consequences of salinity-induced stress on germination. The enhancement of water absorption and cell wall flexibility, coupled with the activation of cytological enzymes, collectively contribute to the role of GA_3 in influencing germination percentage [17]. Comparable results have been documented in studies involving the germination of various other plant species, including *Avena sativa*[18], *Hordeum* vulgare [19], Lathyrus sativus[20], Ricinus communis[21], Satureja thymbra [22],Triticum aestivum[23], and Phaseolus mungo [24].

Effect of Salinity and Priming on the Seedling Growth Performance of the four seeds

Despite the favourable above-ground growth observed in the dwarf line, a study by [31]reported adverse effects of GA_3 on seedling root length in the Rht12 dwarf of bread Triticumaestivum plants. Specifically, it led to an overall reduction in root length and root dry weight, particularly evident under the influence of 100 mM NaCl. This detrimental impact was more pronounced on the root system than the shoot, attributed to the fact that plants experiencing salt stress tend to develop less water-absorbent roots that grow a slower pace[25].The potential mechanisms underlying the alleviating effects of exogenously applied GA_3 on salt stress were proposed by[26], suggesting that these effects might arise from the activation of specific enzymes involved in RNA and protein synthesis. Furthermore, a separate study by [27] noted that GA_3 treatment resulted in increased development of both shoots and roots in Glycine max plants. This trend could be attributed to the exogenous application of GA_3, which generally stimulates the development parameters of *Avena sativa* plants and mitigates the suppressive impact of salt stress to a certain extent. Additionally, GA_3 has the potential to enhance both the fresh and dry weights of seedlings, thereby accelerating the pace of photosynthetic growth [28].

This observation aligns with similar finding from a study by [29], which demonstrated that salinity led to a decrease in the fresh and dry weights of plants. Their results indicated that the decline in fresh and dry biomass at higher concentrations might result from inadequate water absorption from the growth medium due to physiological desiccation. Agricultural productivity is enhanced through the utilization of various growth promoting hormones. Among these, Gibberellic acid (GA_3) stands out as a key plant hormone that plays a significant role in governing plant growth and development. It exerts influence over crucial aspects such as seed germination, leaf growth, stem elongation, and flowering. Research has shown that gibberellins interact with other essential hormones, thereby regulating numerous metabolic processes within plants [30]. In the case of *Majidea zangueberica*, *Phyllanthus emblica*, *Tectona grandis* and *Tabebuia aurea*, the early growth of their seedlings was adversely impacted by NaCl-induced salinity. However, this negative effect was ameliorated upon the administration of GA_3.

CONCLUSION

This research has provided significant insights into the responses of salt-stressed seeds from, *Majidea zangueberica, Phyllanthus emblica, Tectona grandis* and *Tabebuia aurea* along with the impacts of growth hormone pre-treatments using GA$_3$. Both primed and unprimed seeds of these species exhibited distinct yet slightly varying responses to different salinity environments. Notably, seed priming with GA$_3$ yielded notable improvements in seed germination and seedling growth across all four tree species. Priming was particularly effective in mitigating the negative effects of salt stress on seed germination and early seedling growth, especially up to a salinity level of 50mM NaCl. Unprimed seeds displayed more pronounced decreases in seed germination percentage and seedling growth as salt stress intensified, in comparison to primed seeds. The highest salt levels resulted in substantial reductions in seed germination percentage, prolonged mean germination time, and diminished overall seedling performance with a more pronounce impact on roots compared to shoots. The application of GA$_3$ pre-treatment demonstrated enhanced seed germination percentages, reduced mean germination time, and improved seedling growth performances. This research underscores the effectiveness of seed priming strategies in mitigating the adverse effects of salinity stress on seed germination and early seedling growth under controlled conditions. However, further investigations are warranted to assess the performance of these four GA$_3$ primed tree seeds in terms of vegetative growth and yield within real world field conditions.

CONFLICT OF INTERESTS

The authors declare that there is no competing interest.

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Table:1 Mean comparison of primed and control seeds for seedling growth traits of the four tree seeds irrigated with different salinity levels.

Plant Species (Seed)	Treatment	Germination (%)	Mean Germination Time (days)	Seedling vigour index	Shoot Length(cm)	Root Length(cm)	Seedling Fresh Weight(g)	Seedlings Dry Weight(g)
Phyllanthus emblica	T1	#28.00 ± 0.58c	11.00 ± 0.58c	3.42 ± 0.16c	14.01 ± 0.00b	8.00 ± 0.01c	3.67 ± 0.01c	1.26 ± 0.01c
	T2	19.00± 0.58d	13.00 ± 0.58b	2.66 ± 0.06d	13.97 ± 0.00b	7.53 ± 0.01d	3.02 ± 0.01d	1.15 ± 0.01d
	T3	33.00± 0.58a	9.00 ± 0.58d	4.70 ± 0.00a	16.10 ± 0.01a	10.70 ± 0.04a	5.17 ± 0.02a	2.03 ± 0.01a
	T4	30.67± 0.67b	9.33 ± 0.33d	3.74 ± 0.04b	15.83 ± 0.03a	9.20 ± 0.01b	4.06 ± 0.02b	1.97 ± 0.01b
	T5	16.67± 0.88e	14.67 ± 0.33a	2.06 ± 0.03e	8.31 ± 0.32c	3.64 ± 0.01e	2.51 ± 0.02e	0.60 ± 0.01e
Tectona grandis	T1	26.00 ± 0.58c	12.00 ± 1.00ab	3.14 ± 0.02a	14.29 ± 0.01c	8.28 ± 0.01b	4.05 ± 0.04d	1.17 ± 0.02d
	T2	18.67 ± 0.88b	14.33 ± 0.33a	2.60 ± 0.01c	14.09 ± 0.01d	7.94 ± 0.04c	5.13 ± 0.00c	2.37 ± 0.01c
	T3	30.00 ± 0.58a	10.00 ± 1.00b	2.85 ± 0.03b	16.00 ± 0.02b	8.80 ± 0.01a	6.03 ± 0.01b	4.11 ± 0.01b
	T4	28.67 ± 0.33a	11.33 ± 0.88b	2.51 ± 0.01d	16.08 ± 0.00a	7.53 ± 0.01d	6.36 ± 0.02a	4.01 ± 0.00a
	T5	12.67 ± 0.67d	14.67 ± 0.88a	1.59 ± 0.01e	7.94 ± 0.02e	3.32 ± 0.01e	3.00 ± 0.00e	1.47 ± 0.01e
Majidea zangueberica	T1	19.00 ± 0.58bc	15.67 ± 0.88a	2.37 ± 0.01c	14.10± 0.01c	7.64 ± 0.01b	4.16 ± 0.01b	2.04 ± 0.01b
	T2	17.00 ± 0.58cd	13.33 ± 0.88bc	2.14 ± 0.02d	13.68 ± 0.01d	6.32 ± 0.01d	3.05 ± 0.01d	1.74 ± 0.01c
	T3	23.33 ± 0.88a	10.33 ± 0.33d	3.30 ± 0.01a	15.49 ± 0.01a	7.71 ± 0.01a	5.17 ± 0.01a	2.87 ± 0.01a
	T4	20.33 ± 0.33b	12.33 ± 0.33c	3.16 ± 0.01b	14.60 ± 0.20b	6.43 ± 0.02c	4.08 ± 0.00c	2.06 ± 0.01b
	T5	15.33 ± 0.88d	14.67 ± 0.33ab	1.87 ± 0.01e	7.91± 0.01e	3.24 ± 0.01e	2.12 ± 0.01e	0.87 ± 0.01d
Tabebuia aurea	T1	20.67 ± 0.67a	12.33 ± 0.67a	3.66 ± 0.01c	12.23± 1.18c	6.03 ± 0.01d	4.02 ± 0.01b	1.68 ± 0.01b
	T2	17.67 ± 0.33b	12.33 ± 0.33a	3.62 ± 0.02c	12.08 ± 0.10c	7.58 ± 0.01a	3.57 ± 0.01e	1.51 ± 0.03d
	T3	22.33 ± 0.88a	9.67 ± 0.67b	4.12 ± 0.00a	14.13 ± 0.08a	6.58 ± 0.00c	4.22 ± 0.01a	2.14 ± 0.01a
	T4	20.67 ± 0.33a	11.00 ± 0.58ab	4.02 ± 0.01b	12.56 ± 0.01ab	6.93 ± 0.03b	3.83 ± 0.01c	1.58 ± 0.00c

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	T5	16.67 ± 0.88b	13.00 ± 1.00a	1.93 ± 0.04d	9.70 ± 0.05d	5.12 ± 0.01e	3.68 ± 0.01d	1.10± 0.00e
Plant Species (seeds)	F3,40	106.645***	7.805***	673.504***	33.449***	8780.873***	8337.457***	14204..520***
Treatment	F4,40	222.892***	28.646***	1151.665***	389.873***	44310.053***	15224.096***	19894.511***
PS ×Trt	F12,40	17.795***	2.093*	94.363***	10.788***	3729.433***	2117.785***	3014.877***

Table 2: One way Anova for primed and control seeds under different seedling growth traits

Df (F4,10)	*Phyllanthus emblica*	*Tectona grandis*	*Majidea zangueberica*	*Tabebuia aurea*
Germination (%)	117.825***	134.667***	20.357***	12.425**
Mean Germination Time (days)	23.955***	5.424*	11.382**	3.810*
Seedling vigour index	164.184***	1082.817***	2897.484***	1836.603***
Shoot Length(cm)	477.555***	46945.388***	1125.926***	9.010**
Root Length(cm)	17390.861***	12269.390***	21474.935***	4298.533***
Seedling Fresh Weight(g)	3334.154***	5122.494***	22647.833***	1030.200***
Seedlings Dry Weight(g)	5089.109***	19484.011***	5841.850***	953.167***

RESEARCH ARTICLE

Named Entity Recognition using Transfer Learning on Biomedical Literature Documents

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ABSTRACT

This research work focuses on using natural language processing (NLP) techniques to extract important information from electronic medical records (EMRs) related to adverse drug reactions (ADRs). Specifically, the goal of the research is to extract entities such as prescribed drugs with their dosage, symptoms, and illnesses mentioned in the EMRs. The extracted entities will be processed further to identify any adverse reactions that may be associated with the prescribed drugs. The proposed approach, called Named Entity Recognition using Transfer Learning on Biomedical Documents (NER-TL-BioMD), uses a dictionary-based strategy to identify adverse reactions and was found to outperform a baseline NER model in terms of F1-scores for identifying drug, disease, dosage, and Symptoms entities. This type of research is important as it can help improve patient safety by identifying potential adverse reactions to prescribed drugs. By using NLP techniques to extract information from EMRs, researchers can gain insights into patterns of adverse reactions and develop strategies to reduce their occurrence. It also highlights the potential of using advanced technology to support healthcare professionals in making more informed decisions regarding patient care.

Keywords: NLP, EMRs, NER-TL-BioMD, NER, F1

INTRODUCTION

Pharmacovigilance
In the medical field, extracting valuable information from written documents, such as medical literature, poses a challenging task for researchers and industry professionals. These documents contain rich, unstructured information.

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Electronic Medical Records (EMR) provide insightful data that aids healthcare management in making informed decisions. Developers leverage advancements in Artificial Intelligence (AI) to extract hidden information from unstructured data. The medical domain encompasses a vast corpus, including literature documents, websites, forums, and EMRs, all containing text-heavy content. Text mining, a research area focused on analyzing large text corpora, plays a key role in deriving actionable insights. Natural Language Processing (NLP) is an essential concept in text mining, where AI techniques assist in extracting structured information from big data. NLP libraries are actively being developed to identify important keywords within EMRs. In the field of life sciences, the constant advancements in research and discoveries have given rise to a plethora of applications aimed at conducting diverse analyses. One notable example pertains to individuals who consume drugs, as they may encounter side effects referred to as adverse reactions (ADR) [1, 2]. ADR represents the undesirable responses that can manifest even when taking the recommended dosage of prescribed medications. The range of ADRs spans from relatively minor conditions like skin rashes to more severe complications such as renal problems, cardiovascular breakdown, and, in extreme cases, even death. Considering the substantial impact ADRs can have on a significant population, it becomes imperative to accurately identify these reactions in order to safeguard individuals from the harmful consequences that may arise from medication usage[3, 4 and 5].

The field of Pharmacovigilance (PV) encompasses various subcategories, including the identification, evaluation, and prevention of adverse drug reactions (ADR) associated with clinical medications. PV practices are carried out in two distinct phases: pre-marketing clinical trials and post-marketing surveillance. Pre-marketing trials aim to assess the positive effects of drugs and typically involve a small population over a limited duration. However, these trials often fail to capture many negative drug effects. On the other hand, post-marketing surveillance involves the collection and analysis of data related to marketed drugs and their outcomes from healthcare professionals, pharmacists, and consumers [6-8]. To facilitate data collection in this context, many countries have implemented online data collection systems. Consequently, these systems generate substantial amounts of data, and the manual analysis of such data becomes laborious and challenging. Information mining has emerged as an invaluable tool for uncovering the relationship between drugs and their associated adverse drug reactions (ADR) using post-marketing surveillance data [9-13]. One crucial step in conducting text analysis is the extraction of named entities. In the context of extracting ADR from Electronic Medical Records (EMR), the primary challenge lies in the extraction of these named entities. The techniques employed for extraction rely on curated lists of drug-related names, diseases, and symptoms, which serve as the foundation for the analysis process.

Role of NER in PV

In this research work, the major issue of NER extraction from the EMR has been focused to identify the important entities during ADR processing. The arrangement expected this research work to separate the important elements, for example, endorsed chemicals with dose. Also it extracts the manifestations and illnesses referenced in the EMRs. The separated elements will be prepared for further downstream to connect the elements. Then, it influences the word reference based strategies to hail any side effects which might actually be unfriendly medication responses of the recommended meds. A vital segment in our concocted arrangement utilized a custom-made NER model to remove the key elements from EMRs. The cutting edge Named Entity Recognition models fabricated utilizing profound taking in methods [13] remove elements from text sentences by not just recognizing the catchphrases or semantic state of substances. In addition to utilize the element in the sentence, the NER methods are being applied with profound techniques. The NER models influence the closeness of different words which show up alongside the substance in the medical literature documents with per-prepared word embedding of the language model. Among the critical difficulties in preparing NLP dependent models is the accessibility of sensible estimated, great explained datasets. Further, in a commonplace modern setting, the general trouble in gathering huge space master time, and the absence of apparatuses and methods for viable comment alongside the capacity to audit such comments to limit human mistakes, influences exploration and seat checking new learning procedures and calculations. Furthermore, models like NER frequently need huge measure of information to sum up well to a jargon and language area. Such huge measures of preparing information are frequently inaccessible or hard to fabricate or combine. To work with small datasets, transfer learning (TL) is the best alternative to train the models. Transfer learning is act like a bridge

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to fill the gap between the industrialists and academics. For image processing, TL strategies [3] are generally effective. Nowadays, in NLP, TL is playing a major role by means of the pre-trained models and word embedding. In the digital epoch, the arising advance leads the dominance of Artificial Intelligence (AI). Machine Learning (ML)is an unavoidable field of AI. The role of ML decreases and increases the labor and experiences respectively from the colossal measure of information. The job of AI in different area like training area, monetary administration, and transportation, medical services the board, and so forth creates part of freedoms to the AI analysts and gifted designers. IN the life science domain, medical related services are having huge innovation of progression with the AI. In the year 2020, the Covid-19 is a pandemic circumstance and AI has being assumed a significant part to discover the presence of sickness in the people. Specialists had discovered the illness via preparing information accessible by utilizing AI model and ready to foresee the existence of Covid-19. Still it is important to expand the exactness of the AI model. Then again, enormous measure of articles identified with the existence science has being distributed in the mainstream information bases like PubMed, WebMD, and so forth these articles are having parcel of covered up data. Numerous association and medication producers has contributed to remove the concealed data from the enormous measure of information. Pharmacovigilance is one of the significant region, where, it needs to screen the name record of the medication before its delivery in to the market.

Extricating the elements like sicknesses, substance compound, dynamic fixings, sex, indications, measurement levels, dose structures, course of organization, Symptoms, area, species, unfavorable response, and so forth are troublesome assignment. The enormous measure of writing reports accessible over the web are in unstructured organization. For instance, electronic wellbeing records, clinical preliminaries are has distinctive configuration dependent on the nation's guidelines. Distinguishing the mentioned substances from the un-structured record is very difficult assignments for the both analysts and engineers. From the literature documents, producing the toxicological report tremendously relies upon these elements, to remove the contextual analyses and other data. These substance extraction helps various analysts. It also helps to create report generators to diminish the human time taking for delivering the reports that are follows, clinical examination, electronic wellbeing records, toxicology reports, and so forth. Greater part of the reports are in unstructured arrangement and hard to get to the data. A few methodologies, for example, word reference based, AI based and crossover based drew nearer are proposed to extricate these substances from the immense measure of unstructured information.

Word reference based technique is more financially savvy when contrasted with the AI based methodology. Keeping up with and refreshing the corpora prompts immense equipment and capacity costs. AI [1] based strategy which is being implemented by Transfer Learning (TL) techniques have create much exactness. On the other hand, developing a model based TL technique is by and large simple by the new movement of the data set advances which simplicity to develop a gigantic measure of corpus. The corpus could be worked from data that are accessible in the drug website pages. These data can be utilized for different kinds of Natural Language Processing (NLP) applications to get the valuable insight. NLP project these difficulties and give important bits of knowledge. This arising innovation inevitably depends on life science word references and working AI model to foresee the named elements. The proposed research work has been focused on Named Entities Recognition (NER) on the writing reports accessible over the web. Cross breed based methodology has been proposed to recognize the substances. Illnesses, substance compound, manifestations, dose structures and course of organization. Separate word references has been worked for the previously mentioned substances. The unstructured reports are changed over into a design and the named substances are coordinated with the string in word references. The coordinated with words are clarified with the beginning and end position of the characters. The commented on sentences are prepared with the SciSpacy model and custom spacy model was assembled. The model was assessed with the word reference and disarray grid is determined.

Late headways in NLP otherwise called the ImageNet second in NLP [3], have shown huge enhancements in numerous NLP assignments utilizing move learning. Language models like ELMo[4] and BERT [5] have shown the impact of language model pre-preparing on downstream NLP undertakings. Language models are fit for acclimating to changes in the text based area with an interaction of adjusting. Additionally, in this self-regulated learning

situation, there is a certain explanation in sentences, for example predicts the following token (word) given a grouping of tokens showing up prior in the succession. Given this, we can acclimate to another area explicit jargon with very little preparing time and practically no management. NER pointed toward recognizing and distinguishing substance classes in text can help in removing organized data and helping upstream client encounters. The relevance of NER models are far reaching, going from recognizing Symptoms and urban communities in chatbots to open space question replying. The authors [17] have utilized task-explicit explanation apparatuses can limit an opportunity to produce excellent clarified datasets for preparing models. The customary interaction of commenting on information is moderate, however major to most NLP models. It frequently goes about as an obstacle in assessing and bench-marking numerous models, just as in boundary tuning of models. Numerous apparatuses, for example, Doccano [6] exist in the opensource local area that assistance in taking care of this issue. We fostered an in-house device which we could alter for accelerating the comment interaction.

This research work presents discoveries of tests to tackle the modern issue of preparing NER models with restricted information utilizing spaCy [7] , a cutting edge mechanical strength normal language handling bundle, alongside the most recent strategies in move learning. In this research work, we present our way to deal with extricating organized data from unstructured Electronic Health Records (EMR) [2] which can be utilized to, for instance, study unfriendly medication responses in diseases persons because of synthetic compounds in their items. Our answer utilizes a mix of Natural Language Processing (NLP) methods and an online comment apparatus to streamline the presentation of an exceptionally Named Entity Recognition (NER) [1] model prepared on a restricted measure of EMR preparing information. This work was introduced at the principal Health Search and Data Mining Workshop (HSDM 2020) [26]. It feature a mix of instruments and strategies utilizing the new progressions in NLP pointed toward focusing on space moves by applying move learning and language model prepreparing methods [3]. We present an examination of our strategy to the current mainstream approaches and show the viable expansion in execution of the NER model and the decrease on schedule to explain information. A vital perception of the outcomes introduced is that the F1 score of model 73.4% prepared with our methodology with only half of accessible preparing information beats the F1 score of the clear spaCy model without language model part 70.04% prepared with 100% of the accessible preparing information. We likewise exhibit a comment device to limit area master time and the manual exertion needed to create such a preparation dataset. Further, we intend to deliver the commented on dataset just as the pre-prepared model to the local area to additional exploration in clinical wellbeing records.

RESEARCH METHODOLOGY

Introduction

Considering the crucial role of identifying adverse drug reactions (ADR) resulting from medication on individuals with diseases, it becomes imperative for drug development in healthcare. Pharmacovigilance (PV), as defined by the World Health Organization (WHO) [21], encompasses the science and activities involved in detecting, assessing, understanding, and preventing adverse effects or any other drug-related issues. To fulfill this purpose, drug companies frequently need to incorporate conditions and preconditions of ADR after drug intake. This information assists the PV department in conducting thorough analysis of medications, ultimately reducing or preventing harm to patients. The co-occurrence of diseases and chemicals in an Electronic Medical Record (EMR) for an individual with a disease proves valuable during investigations and analysis for chemical and drug-related manufacturers. However, EMRs are unstructured documents containing valuable data that necessitate careful attention for named entity recognition (NER) extraction. Such extraction facilitates easier analysis and reduces human involvement in generating reports. Implementing an NER extraction application saves organizations significant time. Custom healthcare NER models have been developed to extract phrases related to drug chemicals, dosages, diseases, and symptoms from EMRs. Additionally, a new dictionary has been created to identify more entities. The proposed concept follows the human-in-the-loop approach, and various studies were designed and conducted to train customized NER models. The base models employed for this work include Spacy and SciSpacy [7] [8]. This research process is outlined meticulously, emphasizing the preparation of datasets for the proposed approach.

NER-TL-BioMD The research work employs the NER-TL-BioMD model to accurately identify medical entities such as drugs, dosages, Symptoms, and diseases. Figure 1 illustrates the proposed research methodology. The initial phase involves Python scripts to retrieve and organize clinical notes text obtained from the PubMed website. The work also encompasses the development of newly constructed dictionaries, which are further processed using the spacy string matcher to create newly annotated sentences. To support the annotation process, the PSL (Python-Spacy-Language) annotation tool has been developed, utilizing a "Python-Flask" based REST API as the backend [14]. This tool effectively analyzes document comments and generates the necessary formatted information for training transfer learning models using spacy. A Python module is utilized to leverage the capabilities of the pre-trained spacy language model, while another Python module builds upon the existing blank spacy model and incorporates the annotated information. By applying the TL concept, a new model is created on top of the blank model, resulting in improved performance and accuracy.

Data Collection
In this research work, a comprehensive computational corpus was constructed by analyzing openly accessible sample clinical data. The medication evaluation reports obtained from the "PubMed website" [9, 10] were utilized to prepare the datasets. Specifically, dictionaries were compiled for the identification of various entities including Drugs, Diseases, Dosages, and Symptoms. The acquired documents were subjected to preprocessing techniques to transform them into plain text format. To convert PDF documents into plain text documents, the pypdminer library was employed, ensuring the compatibility of the data for further analysis. A detailed numerical summary of the datasets utilized in this work is provided in Table 1, offering valuable insights into the composition and characteristics of the collected data. To facilitate the annotation process, a customized data annotation system was developed specifically for this research. This system enables the annotation of sentences with relevant entities. Figure 2 illustrates a sample annotation, show casing the marked entities within the annotated sentences. The annotation process involves identifying and labeling the specific entities of interest, such as drugs, diseases, dosages, and Symptoms, within the given sentences. This annotated data serves as a crucial resource for training and evaluating the performance of the NER (Named Entity Recognition) models developed in this work.

To annotate the sentences with entities, the research work employed the "spacy phrase matcher" libraries. Initially, a total of 100 sentences were annotated individually for each entity of interest. The detailed statistics regarding the number of instances for each entity are presented in Table 1, providing insights into the distribution of annotations. Subsequently, the annotated sentences were utilized to train the model using the spacy blank model as the starting point. By leveraging transfer learning techniques, the model was fine-tuned using the annotated data to improve its performance in identifying and extracting the desired entities from text. This training process enables the model to better understand the patterns and characteristics associated with the annotated entities, enhancing its ability to accurately recognize them in unseen text data. In order to train and evaluate the model, the dataset was randomly divided into two parts: 80% for training and 20% for testing. The spacy framework follows a dataset model structure, where each entry consists of a sentence followed by the positions of the entities within that sentence. To ensure that the sentences do not overlap, any redundant or duplicate sentences were removed during the data annotation process. This step was taken to reduce computational time and avoid duplication of information. Figure 3 presents the pseudo code of the proposed model, outlining the steps and procedures involved in training and evaluating the model. The code provides a clear overview of the implementation process, enabling researchers and practitioners to understand the logic and structure of the model's functionality.

The spaCy library gives an assortment of instruments to quick content preparing and model validation. It is created as a measured pipeline to validate the newly built models. The default model (blank model) has a customized NER pipeline which had to be enabled before training a new model. This customization helps the developer to build a new model from the pre-trained model. It avoids unnecessary steps that have to be taken for building a new model from the scratch. This need transfer learning to share the knowledge of the pre-trained model with the newly built datasets. The pipeline of the spacy model contains tasks like content order, POS labeling, named element acknowledgment and so on moreover, these parts can be separately refreshed for adjusting to explicit executions. For

execution of the trials it had centered onto two basic parts of the spaCy pipeline. Those pipeline are having the segments that are liable to change words to vectors and the NER acknowledgment segment. CNN-LSTM are being used by spacy to build a new model. It allows transfer learning to retrain the pre-trained model. Also spacy performs faster than any other NLP models. The execution depends on the progress based structure depicted by the author [21]. The spacy library has a function display which renders the result in the web browser. It provides API to cooperate with the NER model. This makes the developers to extend the work and based on the entity visualization. The spaCy preparing API gets mistake angles and updates the model loads utilizing back-engendering. The spacy based training model was prepared using the TL for identify the medical entities. The proposed model is worked for English language. Utilizing the model which has been prepared for perceiving a couple of covering substances is regularly helpful in the event of restricted measure of preparing information when contrasted with the clear model.

After the dataset preparation phase, this is the second phase to train the model. The tokenized word are converted into word embedding (vector) through the spacy NER pipeline. The tok2vec is the concept based on word2vec and glove [22, 23]. These strategies are being used for analyzing the word with statistical techniques. Each word are embed with a numerical value and used to find the similarities and distance between the words. It also helps to manipulate the sentences with word embedding's. Bidirectional Encoder Representations from Transformers (BERT) and Embedding's from Language Models (ELMo) are two different dynamic and word embedding respectively which are used for language models. The NER model runs on different AI based model to identify the entities are referred as dynamic embedding. It works as bidirectional methodologies. The dynamic embedding used transfer learning to reduce the model training cost. The preparation job executes on crude content corpus containing an enormous number of area explicit strings. Word Embedding's are then acquired from the prepared model that could be utilized as token vectors. spaCy has executed a profound learning execution for acquiring dynamic word embedding's utilizing a surmised language-demonstrating objective. The pretrained covering API [12] inside executes the preparation of this profound learning model given a huge corpus of area explicit content information. The yield of pre-training API is an area explicit dynamic inserting model.

This research work had planned three trials utilizing these two key segments of the spaCy NLP pipeline and prepared different NER models utilizing the clarified preparing information to get ideal execution on test information utilizing the spaCy preparing module [15]. The experimental setup which has been used for this research work is given in the following section system configuration. Blank spaCy model which was prepared with the base spacy English language model (this model has no prepared substances) utilizing commented on preparing information to perceive four custom elements. It didn't give any custom token to vector layer and set the API to utilize default execution of the spaCy NLP pipeline. As the model was at that point prepared on clinical information, we utilized it as a base model and applied exchange learning and retrained it utilizing our in-house explained information. Like the clear models, it is prepared 5 models (for 100 cycles with dropout rate, alpha=0.3) while expanding the preparation information from half to 100% of the accessible preparing information. The exhibition of the prepared models was assessed on the standard test information.

In request to work on the exhibition of move learning models further, we utilized a recently delivered spaCy bundle include, that of pre-preparing. Pre-preparing permits us to introduce the neural organization layers of spaCy's CNN layers with a custom vector layer. This custom vector can be prepared by using an area explicit content corpus utilizing the spaCy library pre-preparing order [12]. The pre-preparing API spaCy has executed a profound learning execution for acquiring dynamic word embedding's utilizing a Language Modeling with Approximate Outputs (LMAO) portrayed in spaCy Language model pre-training [25]. The proposed research work had utilized spacy NLP based data processing API. The API allowed to retrained the pre-trained model and able to overcome the catastrophic forgotten problem. It is examined the space explicit content corpus (which was made by using text sentences from 29774 sentences that has been extracted from the PubMed websites. It had checked the misfortune over age while preparing and it was seen that the misfortune slowly diminished to least around 95 age mark after which it leveled. For working with scientific NLP based problems, spacy has provided scispacy models. "en_ner_bc5cdr_md" is a model which has been trained with medium amount of datasets. This model identifies the

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named entities that are related to the medical terms. The prepared annotated datasets are trained over this model by retraining the pre-trained model. The NLP model is resumed from the beginning. This makes to add the new entities with the existing entities. For this research work, the model is trained with 95 epochs. The dropout rate considered for this model is 2%. Based on the dropout rate the model loss is calculated.

RESULTS AND DISCUSSION

The evaluation of the proposed model is conducted using commonly employed metrics such as precision, recall, and F-score. These metrics provide insights into the performance and accuracy of the model in classifying entities. Precision is a metric that measures the proportion of correctly classified positive labels, specifically the true positives (TP), out of all the positive labels (TP and false positives (FP)) obtained from the datasets. It is calculated using the following equation 4

$precision = \frac{True\ positives}{(True\ positives\ +False\ Positives\ )}$equation 4

Precision reflects the model's ability to accurately identify and classify the relevant entities without incorrectly classifying unrelated entities as positive. By calculating precision, we can assess the model's performance in terms of correctly identifying the desired entities, minimizing false positives, and ensuring reliable and precise result. Recall, also known as sensitivity or true positive rate, is a metric used to measure the proportion of true positive (TP) labels correctly identified by the model out of all the actual positive labels, including both the correctly classified and incorrectly classified labels (false negatives (FN)). It is calculated using the following equation 5

$Recall = \frac{True\ positives}{(True\ positives\ +False\ negatives\ )}$equation 5

Recall provides information about the model's ability to capture and correctly identify all the relevant entities, ensuring that minimal positive labels are missed or incorrectly classified as negative. It is particularly important in scenarios where the identification of all positive instances is crucial, such as in medical diagnoses or anomaly detection.

F-score: The harmonic mean of equation (4) and (5) is given in the equation 6.

$F - measure = \frac{2*Precision\ *Recall}{(Precision\ +Recall\ )}$equation 6

The overall performance for the proposed work is calculated and the results are provided in the table 2.

The results indicate that transfer learning (TL) greatly enhances the performance of named entity recognition (NER) models in the biomedical domain. TL improves accessibility to information and consistently increases model performance on test data. The proposed NER-TL-BioMD approach shows a moderate improvement compared to the existing approach. The retrained model outperforms the blank scispacy model, highlighting the effectiveness of transfer learning. However, caution must be exercised when adding new entities to existing ones, as it can lead to incorrect predictions and reduced accuracy. Additionally, the use of pre-training reduces computational time and improves the accuracy of the proposed model. Evaluation metrics such as precision, recall, and F1 score are calculated for NER models, and the proposed NER-TL-BioMD model consistently achieves higher F1 scores across different entity types (drug, diseases, dosage, and Symptoms). These findings are further supported by the bar diagrams illustrating the model's performance. The retrained scispacy model with the newly built dataset surpasses the performance of the baseline model. The proposed NER-TL-BioMD model, built upon the scispacy model, achieves a decent F1 score. Notably, the F1 scores for all entities demonstrate an approximate 4% increase compared to the baseline model. Furthermore, the custom model developed for this research work achieves an impressive F1 score of 89.28% for drug entities, surpassing the pre-trained model.

Overall, these findings highlight the significance of transfer learning, particularly in the biomedical domain. NER-TL-BioMD demonstrates superior accuracy and outperforms existing models, particularly in identifying drug entities.

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The results that are shown above conveyed that with help of TL in accessibility of preparing information, the presentation of the models on test information consistently increments. It is evident that, there is a moderate increase has been seen with the proposed and existing approach. The retrained model has outperformed well than the blank scispacy model. The transfer learning which add new entity to the existing entity could be cross-over and may produce wrong prediction. This would reduce the accuracy. Moreover, execution produced an indefinite quantity which are seen during the utilization of the pre-preparing that cut down the computational time. Also it helped to increase the accuracy of the proposed model. For each prepared model in general NER assessment measurements are been calculated which incorporates Precision, Recall and F1 Score. Figure 4, 5, 6 and 7 represents bar diagram for the entities drug, diseases, dosage and Symptoms respectively. The proposed work NER-TL-BioMD is compared with blank model add the newly built model was outperformed well than baseline NER. From Figure 4, 5, 6, and 7, it is evident that there is an increase in the F1-Score metrics. The proposed NER-TL-BioMD is able to classify the True Positive and True Negative more accurately. This is happened because of the well-annotated datasets. Table 2 represents, the F1scores of the model for identifying the entities drug, diseases, dosage and Symptoms which has been produced by the NER-TL-BioMD with pre-preparing are reliably greater than other models across the same elements. The scispacy model which has been pre-trained with the "en_ner_bc5cdr_md" model that is retrained with the newly built dataset produced better results than the existing baseline model. The proposed model is added on the existing scispacy model and resulted decent F1 score. It is observed that overall percentage for all the entities have around 4 percentage of increase than the baseline model. The custom model which has been built for this research work produced 89.28 percentage as F1 score for the drug entities and leaded as better model than the pre-trained model.

CONCLUSION

The application of natural language processing (NLP) in the medical field, specifically for named entity recognition (NER), is a noteworthy development. This research work focuses on identifying crucial entities such as diseases, symptoms, drugs, and dosages. The identification of these entities holds significant value in diverse applications like medical chatbots, question-answering systems, and toxicology report generation. Remarkably, the pre-trained model is retrained using newly annotated data, resulting in improved accuracy for the newly added entities. The proposed model exhibits exceptional performance, achieving an impressive overall accuracy of 74.3%. The data utilized in this work is extracted from medical documents sourced from the esteemed PubMed website, ensuring a reliable and robust dataset. The incorporation of transfer learning in this research is an intriguing approach that proves beneficial in enhancing model accuracy, particularly when training data is limited. Furthermore, expanding the range of entities to include additional elements such as route of administration, dosage levels, species, and organs holds promise in augmenting the model's capabilities and versatility. Such advancements open up new avenues for utilizing the model in various healthcare applications. In conclusion, this research work presents promising results and demonstrates the potential to contribute to the development of effective NLP models tailored for the medical domain. The successful identification of important entities and the utilization of transfer learning techniques highlight the significance of this work in advancing the field of NLP in healthcare.

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Table 1. Detailed Description of Prepared Dataset

Dataset	Sentences	Entity Counts			
		Disease	Drugs	Symptoms	Dosage
Training Data	23620	6513	4726	3330	1064
Test Data	05154	0878	0431	0082	0516
Interpreted Sentences	28774	7391	5157	3412	1580

Table 2. Comparative Analysis of Models for Entities

Entity	Metrics	Baseline	ArRaNER
Drugs	Precision	78.86	81.33
	Recall	84.57	83.82
	F-Score	80.19	82.55
Diseases	Precision	89.21	88.1

	Recall	84.45	90.49
	F-Score	86.76	89.28
Dosage	Precision	85.1	86.41
	Recall	88.8	88.31
	F-Score	82.9	87.34
Symptoms	Precision	69.42	71.39
	Recall	79.99	79.06
	F-Score	72.55	75.03
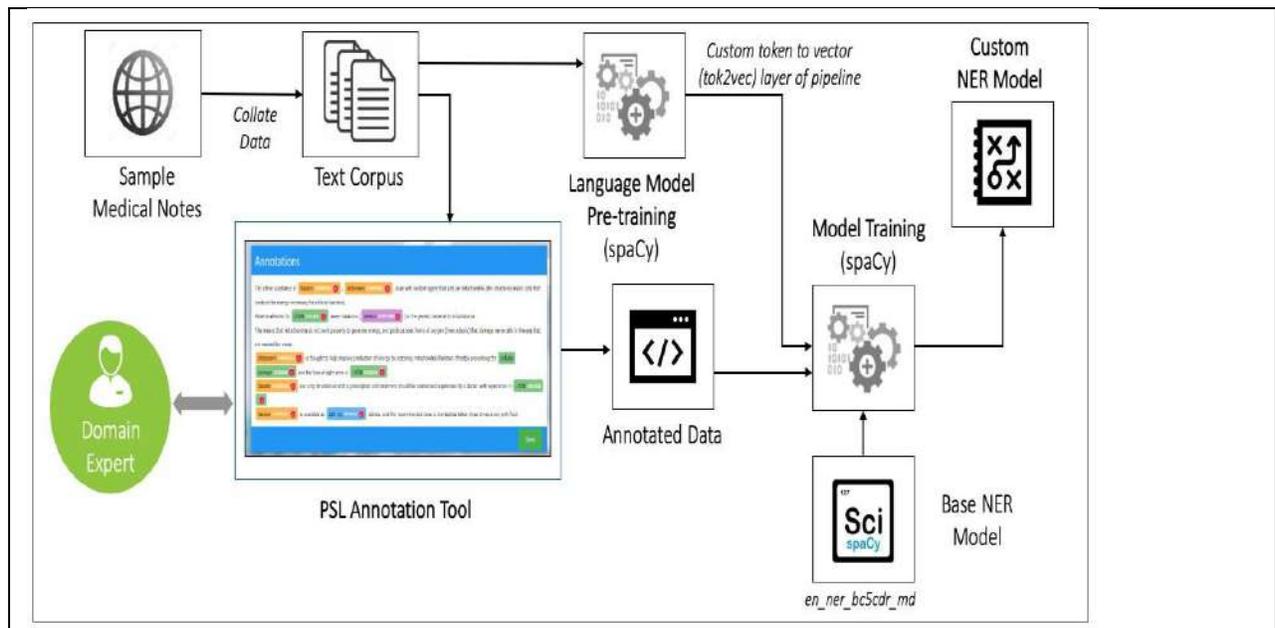
Figure 1: Proposed Research Process

```
{
{
"content": "ointment of LTB is nebulized epinephrine
and dexamethasone.",
"entities": [ [29, 40, "DRUG"], [45, 58, "DRUG"]]
}
}
```

```
Pseudo-code: TLBioNER
Input: Annotated Sentences
Output: Predicted Entities
1. Initialize model features θ
2. Distributed layers features by model
3. Task explicit layer features randomly
4. Set maximum epochs: epochmax
5. for epoch in 1,2 epochmax do
6.      Combine all annotated sentences
7.      Shuffle Data
8.      for minibatchtask in Data do
9.          Calculate Loss L(θ)
10.         Calculate SGD → β(θ)
11.         Update model → θ- = αβθ
12.     end for
13. end for
```

Figure 2. Interpretedd Sentences   **Figure 3 Pseudo-code of NER-TL-BioMD**
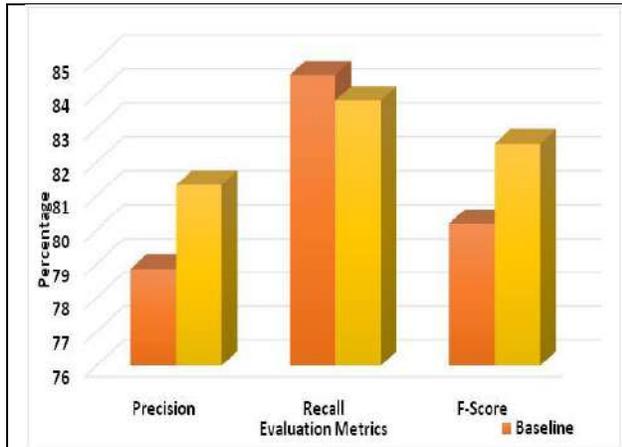
Figure 4 Comparative Analysis of Drug Entity
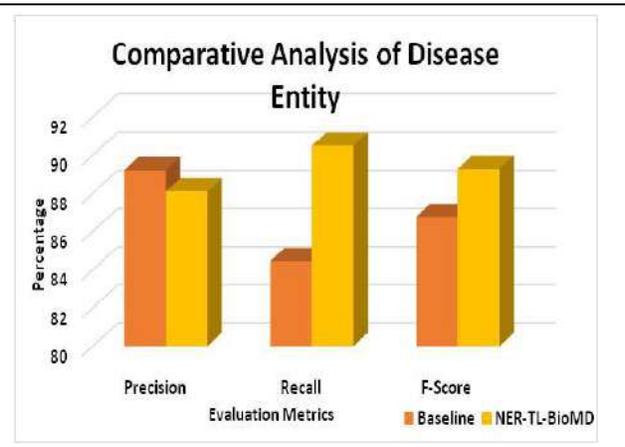
Figure 5 Comparative Analysis of Diseases Entity
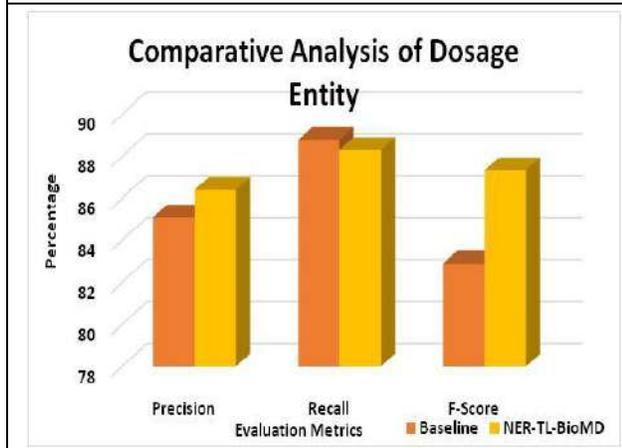
Figure 6 Comparative Analysis of Dosage Entity
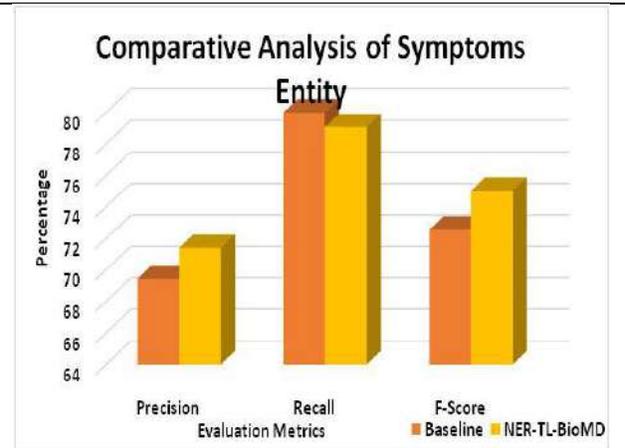
Figure 7 Comparative Analysis of Symptoms Entity

RESEARCH ARTICLE

Studies on the Physiology of Bagrid Cat Fish, *Mystus cavasius* in Tunga River, Karnataka

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ABSTRACT

The present study deals with the physiology of cat fish *Mystus cavasius* in Tunga river of Karnataka. Protein was estimated from testes, ovary and liver at different months. The Gonado Somatic Index, Hepato Somatic Index protein content of ovaries, testis and liver of *Mystus cavasius* in Tunga river was studied during July to October 2017. The GSI values increases gradually and marked enhancement of index occurred. The increases was almost linear during September there was marked fall in GSI value and the GSI index continued to be low during remain period. The GSI value is large in August and September indicates that for is engaged in spawning activity from August to September. Higher values of HSI was found during the resting and preparatory month of October. The minimum HSI was found during in July month. The HSI value is more in male than find then also observed his was high at beginning of the gonadal development their after the value decreased to low level in mature stage. Monthly variation in protein content of the testies, ovary over to increase shows the inverse relationship i.e. increases the protein content in testes and over as during in July on the contain the liver and muscle protein decreases during July indicates their inverse relationship. The protein content in ovary, muscle and liver in more in female compared to male testis, muscle and liver. The biochemical contents are higher in females because they contain large weight and length than male.

Keywords: GSI,HIS, Protein, Ovary, liver, physiology, *Mystus cavasius*

INTRODUCTION

In the world about 22,000 species of fish have been recorded of which 24.73% belongs to fresh water, 6.5% back water and 65.45% of marine ecosystem. India has huge inland water resource interview of 29,000 km of rivers. India is home for more than 10% of global fish diversity. *Mystus cavasius* is widely distributed siloroid fish found throughout the India and Burma in rivers canals, irrigation, channels, ponds and inundated field. It belongs to family Bagridae, *Mystus auspicious cavasius* is a commercially important fishery along Bhadra river. This genera comprises same species *Mystus seenghala, Mystus tengara, Mystus montanus* etc. These fishes are differ from each other. The economic value of any fish depends upon relationship between its length and weight. The ratio of length to weight of fish is known to be a useful index to demonstrate the well being of the fish. It plays a vital rave in the fishery. It helps in establishing the yield and also in comforting, one variable into the other as is often required in during monitoring field operations. The method of studying spawning season is to followed seasonal changes in gonadal weight in relation to body weight expressed as the GSI. Gonad undergo regular seasonal cyclic changes in weight practice in female indicates the spawning season. It is one of important parameter of fish biology. It gives the detail idea regarding the fish reproduction and reproductive stages of the species and helps in ascertaining breeding period of fish. The method of studying of seasonal changes in liver weight decreases relation to body weight expressed as the HSI. Liver undergo regular seasonal cyclic changes in weight in both male and female indicate the spawning season. It is also one of the important parameter of biology. Biochemical compositions of fish tissue are of considerable interest for their specificity in relation to food values of fish and for evaluating their physiological needs at different periods of life. A number of workers have studied the depletive effects of maturation and spawning in the chemical composition of fish (Appa Rao, 1967; Pandy et al., 1976; Piska & Prasad, 1991; Kiran & Puttaiah, 2005). The seasonal bio-chemical variations correlation tests, ovaries, muscle and liver have not been given much attention of *Mystus cavasius* of Tunga river. Hence, keeping in view of the commercial importance of fish, an attempt have been made to study the storage and utilization of liver contents for testicular growth spermatogenesis and oogenesis.

Objectives of the study
➢ To give a brief account on *Mystus cavasius* and know about Scientific position morphology and habitat description.
➢ To study the identifying character of *Mystus cavasius*.
➢ To study the protein content in the liver, gonads and muscles.
➢ To study the GSI and HSI of the *Mystus cavasius*.
➢ To Study the length and weight relationship of the *Mystus cavasius*.

MATERIALS AND METHODS

Study area
The Tunga river is in Karnataka state of Southern India (Figure 1 and 1A). The river is originated born in the Western Ghats at a place called Gangamoola. From here, the river flows through two districts like Chikmagalur and Shimoga District. Tunga river is about 147 km long and merge with the Bhadra river at Koodli Sangama, a small town near Shivamogga of Karnataka. The Tungabhadra flows towards East and merges with the Krishna river in Andhra Pradesh, India. Tunga dam is built at Gajanur,

METHODOLOGY

During the study period (July to October 2017) 2 specimens of *Mystus cavasius* were collected monthly from the local fisherman. The fish were measured and weighed in the fresh condition with the help of measuring board and weighing balance the length weight relationship was estimated by using the

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Log W = Log a + b log l

Where, W =Weight ;L = Length ; a = multiplying constant ;b = exponent of length. According to the statistical analysis, The values of an average total length were platted against their respective weights. The departure from cubic law has been tested and correlation co-efficient has also been computed to test whether regression co-efficient depart significantly from the cubic value C. The fish *Mystus cavasius* (Figure 2) were collected several time per month from Tunga river during July to October and were obtained from fisherman. They were brought in to the lobaratory and then scarified for further studies. The tissue was processed from protein estimation- GSI and HSI. The protein was estimated as method described by Lory method and to study the Gonadosomatic Index and Hepatosomatic Index. Two fishes were examined per month in 4 mounted duration. The weight of liver and gonads of individual fish was recorded and GSI and HSI was calculated by using formula.

$$GSI = \frac{\text{Weight of Gonad}}{\text{Weight of fish}} \times 100$$

$$HIS = \frac{\text{Weight of Liver}}{\text{Weight of fish}} \times 100$$

Morphological Description

Kingdom	:	Animalia
Phylum	:	Chordate
Sub phylum	:	Vertebrata
Class	:	Actinopterygii (Ray-finned fishes)
Order	:	Siluriformes (cat fish)
Family	:	Bagridae (Bagrid catfishes)
Genus	:	*Mystus*
Species	:	*Cavasius*.

Body is elongated and compressed head conical barbells 4 pair maxillary pair in adult fish reached or cross base of caudal fin but in young specimen do not external beyond the anal fin. Dorsal spine weak first ray of dorsal fin much longer than heat, Adipose fin large and originated from just behind dorsal. Dorsal adipose and caudal fins shaped with melanophore, Lateral line present and straight upper lobe of caudal fin longer than lower lobe and pointed. The male can be easily separated from female big its, It was developed urinogenital papilla.

DESCRIPTION

Grayish with a more or less well defined isolateral longitudinal strip. A dark spot emphasized by a white or pale area along it's ventral margin is just anterior to the first dorsal spine. Dorsal adipose and caudal fins shaped with melanophorer. It is elongated and can pressed body. It's depth ¼ th of standard length. Head is conical, medium longitudinal groove is present on head that extends in position. Villiform teeth are present on jaws and vomerine. 4 pair of brackets extend close to the base of caudal fin. Dorsal spine is weak and freely secreted adipose fin is large and caudal fin is forked. Dioecious, oviparous, distinct pairing and external fertilization. Maximum size: 14-22cm. Fishes are the Valuable source of the high grade protein and other organic products. Fresh water fishes provided valuable source of food supply to inhabitants of countries located in tropical region. Flesh of fish is highly nutritive with 60-80% water 13-20% protein and greater or less amount of fat. It also contain phosphorous and vitamins.

RESULT AND DISCUSSION

Result data are depicted in Table 1-6 and Figures 3-5. *Mystus cavasius* is a fresh water fish. This fish is commercially important as it consumed by large population. Although the reproductive biology of this fish has received attention in other areas by many workers. Systematic study pertaining to the biochemical changes in response to different mounts. Hence in the present investigation observation on aspects such as length weight relationship condition changes in to GSI. HSI biochemical changes during the 4 mouth reproductive cycle has been studied. The study of length weight relationship of primary importance in setting up yield equation in estimating the number of fish landed and in comparing population in time and space. The study of length weight relationship also gives an idea of their growth rate generally the length of fish increases. The weight also increases. Showing that the width of the fish is a function of its length.

Maximum length reported = Male = 20cm.
                         = Female = 21.3cm
Weight of *Mystus cavasius* = Male = 75g
                          = Female = 232.1 g

Compare to male and female the female inhaling more weight and length than male.
There was a fare degree of correspondence between maturity stages. GSI values and historical events. The GSI values increases gradually and marked enhancement of index occurred from idly. The increases was almost linear during September there was marked fall in GSI value and the index continued to be low during remain period. The GSI value is large in August and September indicates that for is engaged in spawning activity from August to September. The breeding season of the animals can be determined by several methods such as by GSI measuring gonadal weight, Ganado somatic index is a function of the breeding cycles of fishes. The gonadosomatic index involves determination of the ratio of gonadal weight to the body weight. Compare to male and female the female as high value of GSI than male. Because the female have high value of gonad and weight compared to male. The HSI also known as the hepatosomatic index. Like GSI, HSI also varies during the reproductive cycle in fishes. Because of involvement of liver is strongly correlated to vitellogenic activity. Seasonal changes in the HSI indicates that liver undergo went more or less parallel changes in weight in 4 months.

 HSI and GSI also exhibit inverse relationship suggesting that the liver supports to spermatogenesis and organic activity. Higher values of HSI was found during the resting and preparatory month of October. The minimum HSI was found during in July month. The HSI value is more in male than find then also observed his was high at beginning of the gonadal development their after the value decreased to low level in mature stage. Protein is necessary for the physiology of the cell. According to body protein reserves are utilized for gonads growth in fish. Total protein of the muscle, liver, ovary and testes showed fluctuations during the reproductive cycle. They exhibit well marked trend of build up and utilization in order to meet the needs of reproductive metabolism. In the present study the monthly variation in protein content of the testies, ovary over to increase shows the inverse relationship i.e. increases the protein content in testes and over as during in July on the contain the liver and muscle protein decreases during July indicates their inverse relationship. The protein content in ovary, muscle and liver in more in female compared to male teties, muscle and liver. The protein content in ovary is more in October in August and in tests also protein content more in October and less in August, month. And the protein content in muscle more in September and less in July compare t o male and female the protein content in more in female. The protein content in liver is more in October and less in July both in male and female and the protein content more in female to male. Norman has reported that the stage of gonads may play a great role in the biochemical composition of a fish. Hence, the observation made here is in agreement with Norman (1962); Singh et al., 1993; Dhawan and Sexena (1998); Kiran & Puttaiah (2005); Kour and Kour (2006), Joseph Marykuttu et. al., (2011), Shendge et al., (2012); Ashashree et al (2013). The proteins in the flesh of fish are important for the tissue building activity of those who consume them.

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Protein cycle does not show any relationship with intensity of feeding. Low value of protein content in winter or post-monsoon season may be a consequence of greater utilization of protein for energy requirements in the season.

Water Analysis

The color of the water indicates it's turbidity. If the turbidity of water is high the fishes cannot survive in that region. This is because the mud particles present in that water results in bladder clot or gill dat. The water has low turbidity and it is suitable for the existence of *Mystus cavasius*. pH is the negative logarithm of hydrogen ion *Mystus cavasius* requires pH around 7-8. That mean, it requires the pH which is slightly basic or neutral. As in this study Tunga river show the pH values of 7.2 to 7.8. *Mystus cavasius* required temperature 16°-25° in the present study the observed the water temperature is around 16.4 to 17.2. All living organisms are dependent on oxygen to maintain metabolic process to produce energy. For growth and reproducing. The amount of oxygen present in the water is called as dissolved oxygen. It is by product of photosynthesis by algae and other hydrophytes. The present investigation reveals the dissolved oxygen content was range from 6.8 to 8.8mg/l. The total hardness in the Thunga river was 124.2 to 132.6mg/lFishes are the Valuable source of the high grade protein and other organic products. Fresh water fishes provided valuable source of food supply to inhabitants of countries located in tropical region. Flesh of fish is highly nutritive with 60-80% water 13-20% protein and greater or less amount of fat. It also contain phosphorous and vitamins.

CONCLUSION

The present investigation gives information about the protein content in the gonads, muscles, and liver of *Mystus cavasius*. The investigation give the protein content for 4 month duration.

- The length and weight gives the relationship of length and weight. If the fishes length increases the weight also increases. The weight is depends on length of fish and the females *Mystus cavasius* is largest than male. It indicates that the female is target than male.
- The GSI (Gonadosomatic index) gives a relationship between weight of fish. The GSI value in female fish is larger than male.
- The protein content in the testes, ovary, liver, muscles are larger in female than male. The biochemical contents are higher in females because they contain large weight and length than male.

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Table 1: Length of the fish for 4 months in cm

Sex	July	August	September	October
Female	21.3 cm	20 cm	19 cm	16.2 cm
Male	20 cm	19.6 cm	18.4 cm	14.5 cm

Table 2: Weight of the fish for 4 months in cm

Sex	July	August	September	October
Female	232.1g	228.1g	206g	114.3g
Male	75g	68g	52g	35g

Table 3: Gonado Somatic Index of *Mystus cavasius*

Sex	July	August	September	October
Female	0.035	0.034	0.021	0.022
Male	0.083	0.081	0.075	0.074

Table 4: Hepato Somatic Index of *Mystus cavasius*

Sex	July	August	September	October
Female	0.0019	0.0029	0.0032	0.0033
Male	0.0069	0.0066	0.0073	0.0077

Table 5: Weight of the fish for 4 month in grams

Description	July	August	September	October
Liver	1.86	3.13	3.45	6.83
Ovary	2.13	1.27	1.84	1.97
Muscle	0.12	0.23	0.69	0.19

Table 6: Monthly variation of protein in different organs for male fish

Description	July	August	September	October
Liver	1.75	2.94	3.25	6.47
Ovary	1.99	1.03	1.63	1.88
Muscle	0.14	0.18	0.22	0.20
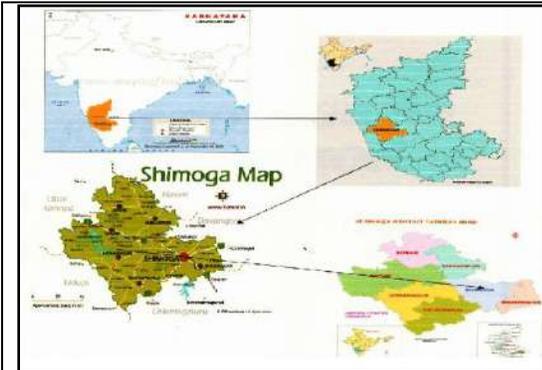
Figure 1: Study area map	**Figure 1A: Fish sampling in Tunga river**
Figure 2: Views of *Mystus cavasius*	**Figure 3: Monthly variations in GSI of *Mystus cavasius***
Figure 4 : Monthly variations in protein content of Ovaries and testis of *Mystus cavasius*	**Figure 5 : Monthly variations in protein content of liver of *Mystus cavasius*.**
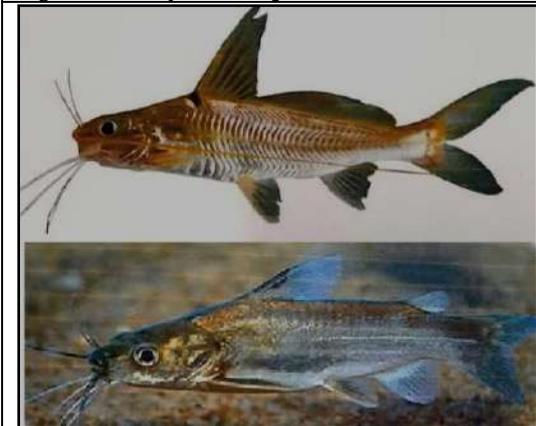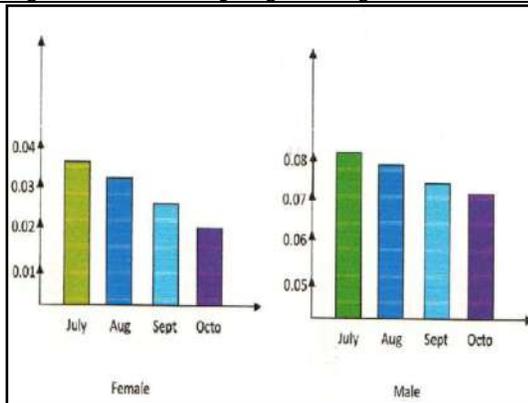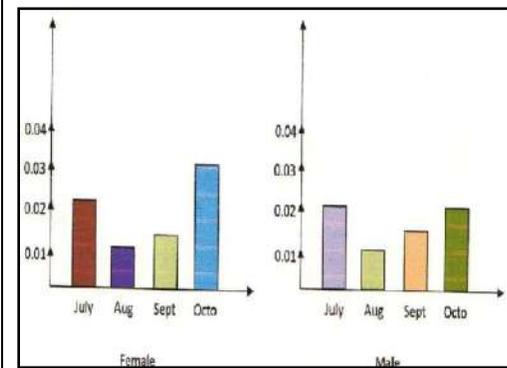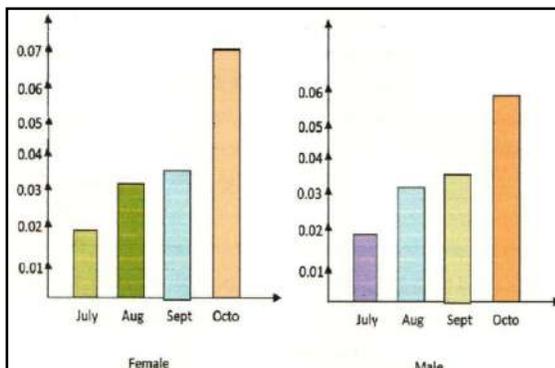
RESEARCH ARTICLE

Molecular Docking Analysis of Siddha Formulation Thalisapathiri Vadagam for Anti-Urolithiasis Activity

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ABSTRACT

In Siddha system of medicine, Thalisapathiri is an herbal drug which is commonly known to treat Respiratory ailments. But Thalisapathiri vadagam, an herbal formulation is indicated for renal calculi in Siddha literature. Renal calculi are an increasing urological disorder by which 12% of the world population is affected. This study is aimed to execute the in-silico computational study of phyto constituents of Siddha herbal formulation Thalisapathiri vadagam for renal calculi against Tamm-Horsfall protein. Docking calculations were carried out for retrieved phyto components against target protein Tamm–Horsfall protein. In the herbal formulation Thalisapathiri vadagam, total of 24 bioactive lead compounds were retrieved. The phyto chemicals such as Rhodoxanthin, Dio sgenin, Apigenin, Gingerol, Piperic acid, Maslinic acid, Epicatechin, Betulonic acid, Coumaric acid, Carvacrol, Germacron, α-thujene, Embelin, Elemene, Costunolide, Cinnamic acid, Elemicin, Kaempferol, piperine, β-sitosterol, glabridin, lupeol, Myrcene, and Vitexin possess maximum of 2-3 interactions accounting for 28-42 % of binding efficacy with the core active amino acid residues present on the target protein. Thereby phyto components which inhibit the target Tamm–Horsfall protein may act as a potential therapeutic agent for management of urolithiasis. The phyto chemicals present in the Siddha formulation reveals significant anti- urolithiasis activity.

It is concluded that these compounds may exerts promising anti-urolithiasis activity by preventing calcium oxalate crystallization. Further studies can be conducted to determine the efficacy of the herbal drug.

Keywords: Renalcalculi, Siddha, molecular docking, Thalisapthiri vadagam, Tamm–Horsfall protein.

INTRODUCTION

Renal calculi or Nephrolithiasis is the process of formation of stone in the kidney or bladder or urinary tract. Nephrolithiasis is derived from the Greek word meaning nephros-kidney, lithos- stone. The epidemiology of renal stone presents with global variations which depends on socio-economic, geographic, and climate factors. The prevalence and incidence of the disease depends on their age, sex, race, and diet[1].An imbalance between water handling and solute clearance by the kidneys result in meta stable state that favours crystallisation thus leads to the stone formation .Renal calculiaffect 10% of the adult population and is 8 times more common in males than females. In children, it is rare and associated with metabolic diseases. 80% of the renal calculi in adult composed of oxalate and phosphate. Nephrolithiasis is leading cause of renal failure among young and middle aged [2].In the last three decades, the prevalence of renal stones has increased worldwide. In the US population, The National Health, and Nutrition Examination Survey (NHANES) was used to determine the prevalence of renal calculi. In a comparison of NHANES II (1976–1980) and NHANES III (1988–1994), it was estimated that renal stone prevalence increased from 3.8 to 5.2% for the period of 20 years. The NHANES data from 2007–2016 reported that the overall weighted prevalence of kidney stone disease was 9.3%[1].The recurrence of renal stone varies among different patients. Approximately half of the patients will have second occurrence of renal calculi within 10 years. More than 10% experience relapses. Specific stone composition leads to recurrence upto 82.4%[3].Management of renal calculi depends on their size and where it is located. Besides the open clinical surgery now there was ESWL and ureteroscopy for the removal of renal calculi. To prevent the surgical intervention and long-term usage of diuretics there is a need of herbal medicine and dietary modification .In Siddha system of medicine renal calculi can be compared with Kalladaipu. Various herbal and herbo mineral formulations are used for the management of Kalladaipu. Thalisapathiri is an herbal drug which is commonly known to treat various respiratory ailments. But in a Siddha literature named Aathmaratchamirtham the polyherbal formulation THALISAPATHIRI VADAGAM is indicated for Kalladaipu[4].Many of the herbs included in the formulation has anti-urolithiatic and diuretic in nature. Tamm-Horsfall protein THP is produced by renal tubular cells of distal loop of Henle[5]. Tamm-Horsfall protein is a urinary defense factor, and its deficiency leads to the major contributing factor for human nephrolithiasis[6]. THP powerfully inhibits the aggregation of calcium oxalate but abnormal structural THPs may promote calcium aggregation[7]. Binding of phyto components from the herbs with the core amino acids (527, 528, 529, 534, 583, 585, 586) of the targets by forming hydrogen bond will hinder the function of the target protein Tamm–Horsfall protein (PDB) -4WRN which is involved in calcium oxalate crystallization. Thereby phyto components which inhibit the target Tamm–Horsfall protein may act as a potential therapeutic agent for management of urolithiasis and related symptoms. So, this study aims to analyse the in-silico molecular docking analysis of Thalisapathiri vadagamfor anti-urolithiasis activity against the target Tamm-Horsfall protein.

MATERIALS AND METHODS

The crystalline structure of the target protein Tamm–Horsfall protein (PDB) -4WRN Fig. I was retrieved from protein data bank and the protein clean-up process was done and essential missing hydrogen atom were being added. Different orientation of the lead molecules with respect to the target protein was evaluated by Autodock program and the best dock pose was selected based on the interaction study analysis.

METHODOLOGY

Docking calculations were carried out for retrieved phyto components Rhodoxanthin, Diosgenin, Apigenin, Gingerol, Piperic acid, Maslinic acid, Epicatechin, Betulonic acid, Coumaric acid, Carvacrol, Germacron, α-thujene, Embelin, Elemene, Costunolide, Cinnamic acid, Elemicin, Kaempferol, piperine, β-sitosterol, glabridin, lupeol, Myrcene, and Vitexinagainst target protein Tamm–Horsfall protein. Essential hydrogen atoms, Kollman united atom type charges, and solvation parameters were added with the aid of AutoDock tools[34]. Affinity (grid) maps of ×× Å grid points and 0.375 Å spacing were generated using the Autogrid program[34]. Auto Dock parameter set- and distance-dependent dielectric functions were used in the calculation of the van der Waals and the electrostatic terms, respectively. Docking simulations were performed using the Lamarckian genetic algorithm (LGA) and the Solis & Wets local search method[35]. Initial position, orientation, and torsions of the ligand molecules were set randomly. All rotatable torsions were released during docking. Each docking experiment was derived from 2 different runs that were set to terminate after a maximum of 250000 energy evaluations. The population size was set to 150. During the search, a translational step of 0.2 Å, and quaternion and torsion steps of 5 were applied.

RESULTS AND DISCUSSION

In the polyherbal formulation a total of 24 bioactive lead compounds were retrieved from the herbs (Table I). From the herbs, the phytochemicals such as Rhodoxanthin, Diosgenin, Apigenin, Gingerol, Piperic acid, Maslinic acid, Epicatechin, Betulonic acid, Coumaric acid, Carvacrol, Germacron, α-thujene, Embelin, Elemene, Costunolide, Cinnamic acid, Elemicin, Kaempferol, piperine, β-sitosterol, glabridin, lupeol, Myrcene, and Vitexin. When comparing the binding efficacies of the phytochemicals (Table III) it was found that the Rhodoxanthin which has a lowest binding affinity of -7.77 kcal/mol and had 3 interactions with amino acid residue 527 TYR,529 LEU and 534 SER (Table IV) , secondly β-sitosterol which had the binding affinity of -7.33 kcal/mol which had 2 interactions with 527TYR,528 PRO followed by diosgenin ,Glabridin, vitexin, Lupeol, Maslinic acid, betulonic acid, costunolide, Germacron which had a binding affinity of -7.28 kcal/mol, -6.90 kcal/mol, -6.90 kcal/mol, -6.70 kcal/mol, -6.65 kcal/mol, -6.65 kcal/mol, -6.56 kcal/mol, -6.07 kcal/mol respectively. The amino acid 529binds with maximum of 18bioactive compounds namely Rhodoxanthin, Apigenin, Gingerol, Piperic acid, Epicatechin, Betulonic acid, Coumaric acid, Carvacrol, Germacron, Embelin, Elemene, Costunolide, Cinnamic acid, Elemicin, Kaempferol, Myrcene and Piperine. The amino acid 527 binds with the maximum of 13 phytochemicals and the amino acid 528 and 534 binds with 11 phytochemicals present in the formulation. All the 24 phytochemicals present in the formulation possess maximum of 2-3 interactions accounting for 28 – 42 % of binding efficacy with the core active amino acid residues present on the target protein Tamm–Horsfall protein.

CONCLUSION

Based on the results of the computational analysis it was concluded that the bio-active compound's present in the herbal formulation revels significant binding against the target Tamm–Horsfall protein by interacting with active amino acid present on the active site thereby it was concluded that these compounds may exerts promising anti-urolithiasis activity by preventing calcium oxalate crystallization. It was concluded that the phytochemicals present in the siddha formulation Thalisapathiri vadagam reveals significant anti- urolithiasis activity.

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Table 1. List of Phytocomponents from the Herbs

PDB	Name of the Target
4WRN	Tamm–Horsfall protein

S.no	Herbs	Phytochemicals
1	*Taxus baccata* (Taxaceae),	Rhodoxanthin[8]
2	*Solanum trilobatum* (Solanaceae),	Diosgenin[9]
3	*Solanumsu rattense* (Solanaceae),	Apigenin[10]
4	*Zingiber officinale*(Zingiberaceae),	Gingerol[11]
5	*Piper nigrum* (Piperaceae),	Piperic acid[12]
6	*Piper longum* (Piperaceae),	Piperine[13]
7	*Terminalia chebula* (Combretaceae),	Maslinic acid[14]
8	*Terminalia bellirica* (Combretaceae),	EpiCatechin[15]
9	*Phyllanthus emblica* (Euphorbiaceae),	Betulonic acid[16]
10	*Cuminum cyminum* (Apiaceae),	Coumaric acid[17]
11	*Trachyspermum ammi* (Apiaceae),	Carvacrol[18]
12	*Curcuma angustifoli a*(Zingiberaceae),	Germacron[19]
13	*Anethum sowa* (Apiaceae),	α-thujene[20]
14	*Embelia ribes* (Myrsinaceae),	Embelin[21]
15	*Elettariacarda momum* (Zingiberaceae)	Elemene[22]
16	*Saussurea lappa* (Asteraceae),	Costunolide[23]
17	*Cinnamomum verum* (Lauraceae),	Cinnamic acid[24]
18	*Myristica fragrans* (Myristicaceae),	Elemicin[25]
19	*Syzygiumaromaticum* (Myrtaceae),	Kaempferol [26]
20	*Mesua ferrea* (Clusiaceae)	β-sitosterol [27]
21	*Glycyrrhiza glabra* (Fabaceae),	Glabridin[28]
22	*Wrightia tinctoria* (Apocynaceae),	Lupeol[29]

23	*Cinnamomum tamala* (Lauraceae)	Myrcene[30]
24	*Saccharum officinarum* (Poaceae),	Vitexin[31]

Table 2: Ligand Properties of the Compounds Selected for Docking Analysis

Compound	Molar weight g/mol	Molecular Formula	H Bond Donor	H Bond Acceptor	Rotatable bonds
Rhodoxanthin	562.8 g/mol	$C_{40}H_{50}O_2$	0	2	9
Diosgenin	414.6 g/mol	$C_{27}H_{42}O_3$	1	3	0
Apigenin	270.24 g/mol	$C_{15}H_{10}O_5$	3	5	1
Gingerol	294.391 g/mol	$C_{17}H_{26}O_4$	2	4	10
Piperic acid	218.2 g/mol	$C_{12}H_{10}O_4$	1	4	3
Maslinic acid	472.7 g/mol	$C_{30}H_{48}O_4$	3	4	1
Epicatechin	290.271 g/mol	$C_{15}H_{14}O_6$	5	6	1
Betulonic acid	454.7 g/mol	$C_{30}H_{46}O_3$	1	3	2
Coumaric acid	164.16 g/mol	$C_9H_8O_3$	2	3	2
Carvacrol	150.221 g/mol	$C_{10}H_{14}O$	1	1	1
Germacron	218.33 g/mol	$C_{15}H_{22}O$	0	1	0
α-thujene	136.23 g/mol	$C_{10}H_{16}$	0	0	1
Embelin	294.4 g/mol	$C_{17}H_{26}O_4$	2	4	10
Elemene	204.35 g/mol	$C_{15}H_{24}$	0	0	3
Costunolide	232.323 g/mol	$C_{15}H_{20}O_2$	0	2	0
Cinnamic acid	148.16 g/mol	$C_9H_8O_2$	1	2	2
Elemicin	208.25 g/mol	$C_{12}H_{16}O_3$	0	3	5
Kaempferol	286.239 g/mol	$C_{15}H_{10}O_6$	4	6	1
β-sitosterol	414.7g/mol	$C_{29}H_{50}O$	1	1	6
Glabridin	324.4 g/mol	$C_{20}H_{20}O_4$	2	4	1
Lupeol	426.7 g/mol	$C_{30}H_{50}O$	1	1	1
Myrcene	136.238 g/mol	$C_{10}H_{16}$	0	0	4
Apigenin	270.24 g/mol	$C_{15}H_{10}O_5$	3	5	1
Vitexin	432.4 g/mol	$C_{21}H_{20}O_{10}$	7	10	3

Table 3: Summary of the Molecular Docking Studies of Compounds against Tamm–Horsfall Protein (PDB) - 4wrn

Compound	Est. Free Energy of Binding	Est.Inhibition Constant, Ki	Electrostatic Energy	Total Intermolec. Energy	Interact. Surface
Rhodoxanthin	-7.77 kcal/mol	2.02 uM	-0.03 kcal/mol	-10.15 kcal/mol	1084.326
Diosgenin	-7.28 kcal/mol	4.59 uM	-0.15 kcal/mol	-7.58 kcal/mol	742.602
Apigenin	-4.33 kcal/mol	670.16 uM	-0.42 kcal/mol	-5.78 kcal/mol	537.687
Gingerol	-5.73 kcal/mol	63.01 uM	-0.14 kcal/mol	-6.77 kcal/mol	551.178
Piperic acid	-4.40 kcal/mol	597.15 uM	-0.22 kcal/mol	-5.27 kcal/mol	517.564
Maslinic acid	-6.65 kcal/mol	13.43 uM	-0.15 kcal/mol	-6.35 kcal/mol	691.504
Epicatechin	-5.98 kcal/mol	41.16 uM	-0.58 kcal/mol	-6.16 kcal/mol	541.868
Betulonic acid	-6.65 kcal/mol	13.39 uM	-0.34 kcal/mol	-7.29 kcal/mol	608.923
Coumaric acid	-4.44 kcal/mol	556.92 uM	-0.28 kcal/mol	-4.44 kcal/mol	376.529
Carvacrol	-4.66 kcal/mol	383.33 uM	-0.02 kcal/mol	-5.54 kcal/mol	480.854
Germacron	-6.07 kcal/mol	35.66 uM	-0.12 kcal/mol	-6.07 kcal/mol	502.44
α-thujene	-4.50 kcal/mol	504.06 uM	-0.11 kcal/mol	-4.80 kcal/mol	396.177
Embelin	-5.70 kcal/mol	65.83 uM	-0.26 kcal/mol	-5.67 kcal/mol	464.055

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Elemene	-5.60 kcal/mol	77.92 uM	-0.21 kcal/mol	-6.48 kcal/mol	493.353
Costunolide	-6.56 kcal/mol	15.55 uM	-0.01 kcal/mol	-6.56 kcal/mol	500.629
Cinnamic acid	-3.99 kcal/mol	1.19 mM	-0.05 kcal/mol	-4.59 kcal/mol	393.684
Elemicin	-3.80 kcal/mol	1.65 mM	-0.14 kcal/mol	-4.61 kcal/mol	456.623
Kaempferol	-5.71 kcal/mol	65.58 uM	-0.37 kcal/mol	-6.10 kcal/mol	515.667
β-sitosterol	-7.33 kcal/mol	4.21 uM	-0.24 kcal/mol	-8.78 kcal/mol	733.147
Glabridin	-6.90 kcal/mol	8.71 uM	-0.18 kcal/mol	-5.44 kcal/mol	577.516
Lupeol	-6.70 kcal/mol	12.33 uM	-0.22 kcal/mol	-7.30 kcal/mol	667.424
Myrcene	-4.13 kcal/mol	932.87 uM	-0.16 kcal/mol	-5.18 kcal/mol	427.924
Apigenin	-4.32 kcal/mol	677.57 uM	-0.41 kcal/mol	-5.78 kcal/mol	536.878
Vitexin	-6.90 kcal/mol	8.71 uM	-0.18 kcal/mol	-5.44 kcal/mol	577.516

Table 4: Amino Acid Residue Interaction of Lead and Standard against Tamm–Horsfall Protein (PDB) - 4wrn

Compounds	Interactions	Amino acid Residues								
Rhodoxanthin	3	495 ARG	500 ALA	502 TYR	527 TYR	529 LEU	530 ASP	533 VAL	534 SER	537 THR	570 GLN
Diosgenin	2	484 ALA	485 ARG	502 TYR	527 TYR	528 PRO	530 ASP				
Apigenin	3	500 ALA	502 TYR	527 TYR	528 PRO	529 LEU	530 ASP	533 VAL			
Gingerol	2	495 ARG	529 LEU	534 SER	537 THR	538 ALA	570 GLN	571 PRO	573 GLN		
Piperic acid	2	495 ARG	500 ALA	529 LEU	533 VAL	534 SER	537 THR	538 ALA	570 GLN	571 PRO	573 GLN
Maslinic acid	2	500 ALA	502 TYR	527 TYR	528 PRO	530 ASP					
Epicatechin	3	484 ALA	502 TYR	527 TYR	528 PRO	529 LEU	530 ASP				
Betulonic acid	2	484 ALA	500 ALA	502 TYR	527 TYR	529 LEU	530 ASP	533 VAL			
Coumaric acid	2	529 LEU	534 SER	537 THR	538 ALA	570 GLN	571 PRO	573 GLN			
Carvacrol	2	495 ARG	529 LEU	534 SER	537 THR	538 ALA	564 GLN	570 GLN	571 PRO	573 GLN	
Germacron	1	495 ARG	497 GLU	529 LEU	537 THR	538 ALA	570 GLN	571 PRO	573 GLN		
α-thujene	1	528 PRO	530 ASP	531 MET	568 TYR	645 GLN	647 ARG				
Embelin	2	495 ARG	529 LEU	534 SER	537 THR	538 ALA	564 GLN	570 GLN	571 PRO	573 GLN	
Elemene	2	495 ARG	529 LEU	534 SER	537 THR	570 GLN					
Costunolide	2	495 ARG	529 LEU	534 SER	537 THR	570 GLN	571 PRO	573 GLN			
Cinnamic acid	2	529 LEU	534 SER	537 THR	564 GLN	570 GLN	571 PRO	573 GLN			
Elemicin	3	500	527	528	529	530					

		ALA	TYR	PRO	LEU	ASP					
Kaempferol	2	495 ARG	497 GLU	529 LEU	533 VAL	534 SER	537 THR	564 GLN	570 GLN	571 PRO	573 GLN
β-sitosterol	2	500 ALA	502 TYR	527 TYR	528 PRO	530 ASP	531 MET	533 VAL	568 TYR	647 ARG	
Glabridin	1	484 ALA	502 TYR	527 TYR	530 ASP	645 GLN					
Lupeol	1	500 ALA	502 TYR	527 TYR	528 PRO	530 ASP					
Myrcene	2	495 ARG	529 LEU	534 SER	537 THR	571 PRO					
Apigenin	2	527 TYR	528 PRO	530 ASP	567 SER	568 TYR	569 THR	647 ARG			
Vitexin	3	500 ALA	502 TYR	527 TYR	528 PRO	529 LEU	533 VAL				
Piperine	3	500 ALA	502 TYR	527 TYR	528 PRO	529 LEU	533 VAL				
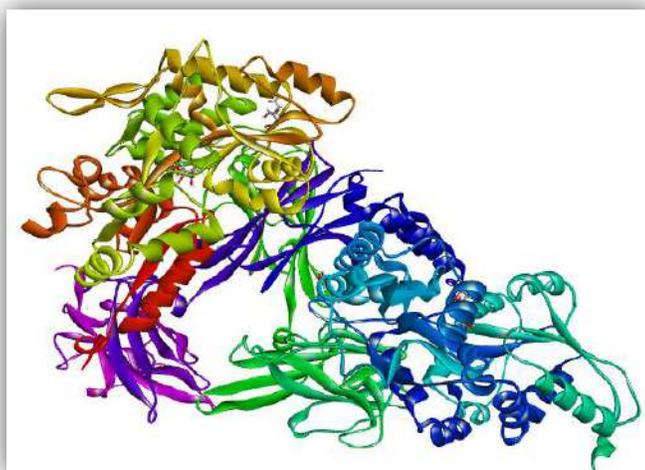
Fig I: 3d- Structure of Tamm–Horsfall Protein (Pdb) -4wrn

Ligands	2D and 3D structure of ligands	Ligands	2D and 3D structure of ligands
Rhodoxanthin		**Diosgenin**	
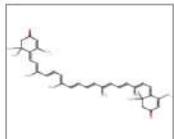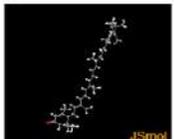
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Apigenin		**Gingerol**	
Piperic acid		**Maslinic acid**	
Epicatechin		**Betulonic acid**	
Coumaric acid		**Carvacrol**	
Germacron		**Thujene**	
Embelin		**Elemene**	
Costunolide		**Cinnamic acid**	

Elemicin		Kaempferol	
β-sitosterol		Glabridin	
Lupeol		Myrcene	
Apigenin		Vitexin	
Fig. 2: 2d and 3d structure of selected ligands.			

RESEARCH ARTICLE

Microbiome Analysis of Rhizosphere of *Santalum album* L. Grown in Tropical Dry Evergreen Forests India

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ABSTRACT

Microbiome of the plant rhizosphere has great impact on plant health and results in high quality by products. Sandal is an evergreen, root parasite with slow growth plant. The present workinvestigatedwiththeassemblageofthebacterialcommunitiesassociatedwithS.albumrhizosphere soil for metagenomicstudies.9,038 bacterial communities were identified using common and unique operational taxonomicunits(OTUs)by QIIME pipe line(1.9.1).The aims were to highlight the importance of assessing the potential role of Actinobacteria using as a culture treated bio fertilizer which was basically having the capacity of inhibiting phytopathogens on rhizosphere soil which helps to improve sandal tree productivity. A field experiment was conducted to grow sandal saplings, Neem tree as host, Actinobacteria as culture treatment without host and, bio fertilizers without host and treatment. Plant morphometric analysis were determined and compared for a one year and two years old tree. The results showed that the effect of Actinobacteria treated bio fertilizer on sandal sapling having good growth on height, basal grith and leaves. Height and basal grith significantly increased when it was treated with Actinobacteria when compared with rest of two experimental saplings. The highest growth rate shows the efficiency of Actinobacteria uptake on rhizosphere level. Actinobacteria can have the ability of promoting growth on one year and two years old sandal tree. Therefore, Actinobacteria treatment should be considered when treated bio fertilizer is applied to soil as fertilizer.

Keywords: *Santalum album*, rhizosphere soil, microbiome, High-throughput　 sequencing, QIIME(1.9.1), Actinobacteria.

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INTRODUCTION

Soil micro organisms have an important role on soil fertility and plant health. The differing physical, chemical and biological properties of the root associated soil, compared with those root free bulk soils are responsible for changes inmicrobialdiversityandforincreasednumbersandactivityofmicroorganismsinthemicroenvironmentofrhizosphere(Vel mourougane et al. 2017).In general, parasites uptake nutrient from their host for their growth, if a parasitic plant that has directly attaches to another plant via a haustorium which has a specialized structure that forms amorphological and physiological link between the parasite and host (Yoshida et al. 2016). *Santalum album* L. (Sandalwood) is a commercially and culturally important plant species belonging to the family Santalaceae and the genus Santalum. There are around 18 sandalwood species of genus Santalum (Baldovini et al. 2011). Among various Santalum species, Indian sandalwood (*S. album*), which is also sometimes referred as east Indian Sandalwood, stands out for its highly valued oil and aromatic wood (Arunkumar *et al*. 2016). However, there is lack of knowledge on the ecology and the distribution of this commercially valued species due to inadequate research (Subasinghe 2013). *Santalum album* L. is an important semi parasitic tree whose roots join to host roots, through haustoria, to acquire water and nutrients. Due to hemi parasitic nature, finding suitable host species is a limitation in establishment of sandalwood plantations (Teixeira et al. 2016). In India, the area under sandalwood is decreasing fast due to illegal collection and its difficulty in plantation establishment (Rocha et al. 2014). Due to over harvesting in its natural habitat in India, it is listed as vulnerable by the International Union for Conservation of Nature (IUCN) and is placed in Appendix II of CITES. Owing to the immense value and its declining population in its natural habitats, opportunity for plantation of sandalwood to satisfy its demand is huge (Jones, 2008). The bio geographical patterns exhibited by soil microbial communities has grown significantly.   This aspect of biodiversity, besides being fundamentally important for our understanding of the forces shaping the bacterial biosphere (Fierer et al. 2007)has practical value because it can provide a scientific basis for modern agriculture. With the development of sequencing technology, meta genomic analysis involves within the application of bioinformatics tools to review the genetic material from environmental, unculturable microorganisms. Considering its successful natural establishment at Sivaganga, this study aimed to identify the host species and enumerate environmental factors supporting its microbial population in the study area. The rhizosphere microbiome of *S. album* has focused on basic 16S rRNA sequencing to evaluate the bacterial diversityanddistinguishesthousandsoforganisms.Therearethreeprimaryphasesinmetagenomicdataprocessing:

1. assembly
2. annotation, and
3. statistical analysis (Thomasetal.2011). We also provided the analysis of soil physic chemical properties and themicrobiome analysis to understand the soil – microbes relationship between soil nutrients which involves in the growth of beneficial microorganisms. Furthermore, the genus of Actino bacter shows highly responsive on plant growth promotion. This will provide opportunity for the cultivation of sandal wood tree and benefits economically .In some literatures they reported that after 3–4 years, the host is no longer necessary for its growth and development. Our aim to grow the one year and two years old sandal saplings without any host. According to our results, we focused on Actinobacteria culture for the growth and development on one year and two years old sandal saplings in RBL nursery, Bharathidasan University, Tamil Nadu.

MATERIALS AND METHODS

Sample Collection and processing
S.albumrhizo sphere soil were collected from V.Pudur, Sivaganga District at 9.9726°N,78.5661° E, Tamil Nadu, India on December 2020 (Fig.1), collected sample was carried out under aseptic procedures were separated in the laboratory and stored at−20°C.

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Soil Physiochemical Properties

A comprehensive study of soil physicochemical and biological properties was analyzed. Soil moisture content was measured by the weighing method. The soil pH was determined using acalibrated pH meter by the microelectrode method (Zhang et al. 1999). The EC (Electrical Conductivity) (Hardie and Doyle, 2012) and organic carbon were determined (Walkley and Black, 1934; Piper, 1966). The available nitrogen was determined by kjeldal method (SubbiahandAsija,1956) available phosphorus (TaleandIngole,2015) by spectro photo meter and potassium by flame emission method (Jackson,1973). Available sulphur in the soil was extracted using 0.15% CaCl$_2$ solution (WilliamsandSteinbergs,1959). Exchangeable calcium and exchangeable magnesium by EDTA titration method (Raij,1966). Generalsoil physical profiles of texture, structure, color and density (Blake and Hartze, 1986), soil porosity, moisture content and water holding capacity (Sankaram, 1966) were determined.

DNA Extraction

DNA extraction using extraction buffer(10 ml) was mixed with sandalrhizo sphere soil(5g)onice and glass beads were added. The mixture was sonicated using a high intensity ultra sonic processor (VibraCell) with a standard 13mm horn soli pro befor 150 seconds. The sample was cooledinice and the sonication repeated. Sodium dodecyl sulphate (SDS) was added (3ml;20%) and blending continued for a further 5 sec. The sample was incubated at 65°C for 1 hr. transferred to centrifuge bottles (50 ml) and centrifuged at 6000g for 10 min. The supernatant was collected, and the soil pellet re-extracted with further extraction buffer (100 ml), incubation at 65ºC for 10 minutes and centrifugation as above.10 ml supernatants were transferred to centrifuge tubes (15 ml) containing a half-volume of polyethylene glycol (5 ml; 30%), and incubated at room temperature for 2 hrs. Samples were centrifuged (8000rpm for 20 min) and the partially purified nucleic acid pelletre suspended in 100 µl of TE. Potassium acetate (400 µl; 7.5 M) was added to a final concentration of 0.5 M. Samples were transferred to ice for 5min then centrifuged (8000rpm,45min) at 4°C to precipitate proteins and polysaccharides. The aqueus phase 0.5ml was extracted with phenol/chloroform and chloroform/isoamyl alcoho land DNA was precipitated by adding 2 volume(1ml) isopropanol. It was incubated at -20°C for overnight, DNA was pelleted by centrifugation (8000rpmfor 20min)and resuspended in TE(50µl) (Yeates et al. 1998).

HTS, Library preparation and Data Quality Optimization

A Qubit 2.0 fluorometer was used to measure DNA samples (Invitrogen, Carlsbad, CA, USA). A Meta Vx TM library preparation kit was used to produce amplicons from 40–50 ng of DNA(GENEWIZ, Inc., South Plainfield, NJ, USA). The hyper variable V3 and V4 regions of bacterial16S rRNA were chosen for amplicon sequencing, followed by taxonomic analysis (Caporaso et al. 2012; Gilbert et al. 2014).GENEWIZ created a set of proprietary primersaiming at the relatively conserved areas of the V3 and V4 hyper variable regions of the 16S rRNA of bacteria. The agilent 2100 Bioanalyzer (Agilent Technologies, Palo Alto, CA, USA) was used to confirm library quality control, and the Qubit 2.0 Fluoro meter was used to quantify it. Adopted the manufacturer's recommendations such as DNA libraries were multiplexed and put into an Illumina Mi Seq device(Illumina, San Diego, CA, USA). The MiSeq control software package (MCS) integrated in the Mi Seq instrument was used to sequence using a 2300 paired end (PE) configuration; image analysis and base calling were accomplished using the MCS (Caporaso et al. 2010). The metagenome sequence of *S. album* associated bacterial community was submitted in NCBI with the accession number of bio project PRJNA832090.

Statistical and Bio informatics Analysis

Sequence analysis was performed using the V search (1.9.6) (Westcott et al. 2015). To determine operational taxonomic units (OTUs), the 16S rRNA gene sequences were trimmed to a average length of 393 bp, sorted by using Cut adapt (v1.9.1). Operational Taxonomic Units were taxonomically annotated following a Basic Local Alignment Search Tool (BLAST) analysis against the Unite Database of each identified representative bacterial sequence done in QIIME software. Alpha diversity analysis was carried out to find the complexity of species diversity for each sample using 6 indices, which include observed species, Chao1 (Chao,1987), Shannon (Shannon,1948), Simpson (Simpson, 1949),abundance-based coverage estimator (ACE) (ChaoandLee,1992) and Good's coverage (Good,1953). Indices

calculation for all the samples was done using QIIME and visualized in R software (Caporaso et al. 2010). Community richness was identified with Chao indices richness estimator of the total number of species in ecology (http://www.mothur.org/wiki/Ace). An index that uses Chao1 algorithm to estimate the OUT number of samples commonly used in ecology to assess the total number of species. (http://www.mothur.org/wiki/Chao).The Shannon index commonly used to reflect the diversity index a for the estimation of microbial diversity(http://www.mothur.org/wiki/Shannon)and Simpson index (http://www.mothur.org/wiki/Simpson) indices were used for the identification of community diversity in all the samples. To characterize the sequencing depth and coverage, the Good's coverage (http://www.mothur.org/wiki/Coverage)was used. Rank abundance curve performed by using R packages and OTU clustered by V search (1.9.6) (Rand, 1971; Hubert, and Arabie, 1985).RDP classifier (Cole et al. 2014) Bayesian algorithm was used to classify the OUT representative sequences of 97% similarity level, and the community composition of each sample was analyzed and summarized at all levels. Taxon assignment was performed using the QIIME(v1.9.1). For each OTU cluster, a representative sequence was screened to perform taxo nomi cannot action. Rank Abundance Curve (RAC) is used to analyze diversity (MacArthur, 1957; Whittaker, 1965) by R packages based on the results of OTU analysis. Rank-abundance curve reflects both species abundance and species uniformity. Species uniformity is reflected by the shape of the curve. The rarefaction curve (Heck et al. 1975)is a useful tool to characterize the species composition of a sample and predicting the abundance of species in a sample. It efficiently deals with the increase of detected species due to the increase in sample size. The observed numbers of OTUs were plotted against the number of extracted sequences by QIIME(1.9.1).

Experimental site and plantation establishment

The study was carried out during one year old (2020-2021) and two years old (2020–2022) sandalwood plantations on RBL nursery field, Bharathidasan University located in Tiruchirappalli district, Tamil Nadu, India 10°40′29″N 78°44′39″E. The climate of the experimental site is semi hot, receiving 387 mm annual rainfall distributed with dryer June - September, wetter January - February, hotter April- May, and cooler October - December. The soil of the study area was low fertile, red soil, with pH (5.4). During summer, the plantation was provided with protective irrigation through the drip irrigation system. The sandal sapling considered in the study were one year and two years old with Actino bacteria culture treatments, bio fertilizers (without treatment) without any host and neem tree as host for morphology analysis.

Treatment and experimental design

The one- and two-year-old sandal tree were taken for the study. For first experiment *Santalum album* seeds were first soaked in Actino bacteria culture for 12 hrs at room temperature. Then the seeds were sown in soil in a RBL nursery, Bharathidasan University. For the second experiment only bio fertilizers are used for the growth. After seed germination and the seedlings developed at least six leaves, 12 cm tall seedlings were trans planted into grow bags (12x12 cm) filled with a mixture of green manure and vermin compost and placed in a greenhouse set up. After the growth of 1-month seedlings, they are moved to the field. As the seedlings grew to over 35 cm in height, the seedlings are directly transferred to the RBL nursery field soil. For the third experiment after sandal sapling plantation on the soil neem tree was planted at the side of sandal sapling which was taken as their host for growth. Compared to all three saplings they show differences in their height, girth and number of leaves present in the one year and two-year-old sandal tree.

RESULTS

Soil Physico chemical Profiles

The soil sample was collected upto 15cm depth and analyzed for available macro nutrients and soil physical parameters. The physio chemical properties of the rhizo sphere soil sample were presented in Table 1. The soil was red in color that has gravelly clay texture. The bulk density values were recorded as 1.34 Mgm^3. The water holding capacity of soil was recorded as 15.6%.The moisture content of the soil was recorded as 13.7%. The pH range was recorded as 5.4. The EC value was recorded as 0.14dsm^1. The organic carbon content was recorded as 6.3%. The

available nitrogen contentre corded as 204.0kgha^1. The available phosphorus content was recorded as 11.00kgha^1. Available potassium content was recorded as 72.0kgha^{-1}.Available sulphur content was recorded as 5.9 mg kg^{-1}. Calcium content was recorded as 9.35 kg ha^{-1}. Magnesium was recorded as 3.86kgha^{-1}.

Sequencing Data
A total of 7,878,805basesnumberswith alength of 235bp were obtained by sequencing16S rRNA from *S. album* rhizosphere soil sample. A total PEreadsof16,741 numbers with 393b peerage length from S.album rhizosphere soil sample. Filtration of raw read sof16Sr RNA were filtered using QIIME quality filters, followed by OTU identification, clustering and analysis (Fig.2).

Operational Taxonomic Unit(OTU)cluster and species annotation
QIIME pipeline (1.9.1) was used to analyses the bacterial diversity in the *S. album* obtained from the sivaganga forest. 16S rRNA sequences number were obtained having a combined length of200-500 base pairs (bp), and 16S rRNA V3-V4 gene profiles were generated from the *S. album* is to evaluate the diversity and abundance of bacterial association, 448 OTUs were identified. Operational Taxonomic Units identification was done with Vsearch software(1.9.6) . Based on ≥97% of sequence similarity, all the effective tags were clustered into OTUs. For each OUT cluster, are preventative sequence was screened to perform taxonomi cannotation. OTUs were taxonomically annotated following a BLAST analysis against the Unite Database of each identified representative bacterial sequenced one in QIIME software.

Diversity Index, Microbial Composition and Statistical analysis
The community compositions of annotated micro bio meindicated that there were 5 Kingdoms, 15 Phylas, 37 Classes, 62 Orders, 75 Families, 53 Genus, and 8 Species in therhizosphere soil of S. album. Alpha diversity refers to the diversity within a particular sample individually, and itis usually represented by the microbial species (i.e., species richness) enumerated in S.album. Alpha diversity analysis was done using Shannon, Simpson and Chaoindces, Rarefaction curves, Rank abundance and good's coverage for 16Sr RNA sample.Alpha diversity consists of plots displaying Shannon, Simpson, andChaoindices,builtusing16SrRNA samples(Fig.3).

Rarefaction Curve
In order to determine whether the sample size is enough and to calculate the species abundance, the rarefaction curve is frequently employed in biodiversity and community surveys. As a result, when the sample size is adequate, the rarefaction curve can forecast the species abundance in addition to determining whether the sample size is adequate. Qiime created the rarefaction curve using random sampling (1.9.1) (Fig.4).

Rank-Abundance Curve
The number of valid sequences in each OTU of a given sample was first calculated, and all the OTUs were then ranked in descending order based on their relative abundance (number of valid sequences). The result was then plotted, with OTU ranking on the X axis and the number of sequences in the OTU on the Y axis. The OTU relative abundance in % might alternatively be the Y axis. The length of the curve on the X axis reflects the number of species present. More species are present if the X axis is stretched. The curve's shape reflects the uniformity of the species. The higher the species homogeneity, the smoother the curve. (Fig.5).

Taxonomy Diversities
The abundant phyla identified in *S.album* using 16S rRNA data were Actino bacteria(23.4%), Proteo bacteria(14.9%), Acidobacteria(7.1%), Chloroflexi(4.1%), Firmicutes(2.3%), Nitrospirae(1.9%), Gemmatimonadetes(1.9%), OD1(0.1%), Armatimonadetes(0.1%), Planctomycetes (0.09%), Bacteroidetes (0.08%), WS3(0.05%), Cyanobacteria (0.04%), Spirochaetes (0.03%). The top 3 phyla present in *S. album* are Actinobacteria, Proteobacteria, Acidobacteria. The top 15 distribution of the abundant classifications of *S.album* rhizosphere soil sample atphylum level (Fig.6). The top 20 bacterial genera of 16SrRNA data based analysis were Acetobacter (2.3%), Lactobacillus (1.9%), Pseudonocardia

(1.3%), Kribbella(0.5%), Iamia(0.36%), Streptomyces(0.34%), Virgisporangium(0.30%), Mannheimi(0.29%), Mycobacterium(0.29%), Bradyrhizobium(0.27%), Rhodoplanes(0.25%), Agromyces(0.25%), Bacillus(0.22%), Mesorhizobium(0.22%), Balneimonas(0.19%), Kaistobacter(0.18%), Nitrospira(0.18%), Candidatus(0.17%), Cellulomonas(0.17%), Pasteurella(0.15%) and Pseudomonas(0.08%). The top 3 genera present in *S.album* are Acetobacter, Lactobacillus, Pseudonocardia. Species distribution using 16S rRNA sequence data based analysis were halophobica(0.7%), ochraceum(0.3%), multocida(0.1%), aureum(0.07%), vinacea(0.05%), marinus (0.04%), scabrisporus(0.04%). halophobicawere the most abundant species present in *S. album* rhizosphere soil. The distribution of the abundant classifications of *S. album* rhizosphere soil sample at species levels(Fig 7)

Treatment and untreated sandal sapling morphology analysis

The one year and two years old sandal saplings were taken for the study. Three types of sandal plantation were done. At first *Santalum album* seeds were first soaked in Actinobacteria culture. For second sapling plantation only with bio fertilizers andfor the third experiment, the sapling was planted with host (neem). The seeds were sown in soil in a RBL nursery, Bharathidasan University. After seed germination saplings were placed in a greenhouse set up. After 1 month, the seedlings are grown up to 30 - 40 cm in height, then the seedlings are directly transferred to the RBL nursery field soil. After 1 year and 2 years, treated and untreated sapling without host and with host(neem)sandal sapling shows some morphological variations in their growth. According to three saplings, the culture treated sandal sapling shows healthy with consistent growth during morphological studies. The sandal sapling was grown in a glasshouse in Bharathidasan University, Trichy with 10°40′29″N 78°44′39″E. Table 2gives the details of field treated with culture and untreated sapling morphology. Table 3 gives the details of field sapling morphology with host (neem) studied in this current experiment.

DISCUSSION

Present study needs to focused on *S. album* microbiome because of *S. album* natural habitat population has experienced substantial decrease due to extensive exploitation for commercial purposes (Teixeira et al. 2016). The conservation status of *S. album* alone has been on alevel of vulnerability as listed by International Union for Conservation of Nature and Natural Resources (IUCN) after the assessment of conservation status held in Viet Namin 1998.The growth of sandalwood is closely affected by its growth environment, especially the soil conditions and host plant because of its hemi parasitic nature (Liu et al. 2009; Ouyang et al. 2016; Teixeira et al. 2016). Sandalwood requires fertile soil with good drainage to exhibit optimum growth. The presence of a host plant for sandalwood has been proven to be essential in the root association through haustoria formation for supplying water and other available nutrients to improve morphological growth (Deepa and Yusuf, 2016).Sandal wood develops strategy by modifying the roots to form haustorium when in physical contact with the roots of the host plants. The formed haustorium would connects and al wood to the host plant, in terms of anatomically, morphologically and physiologically. That connection thus would allow the flow of water and nutrients from the host plant to the parasite plant (Teixeira et al. 2016). Within a year since sandalwood was grown with the host plants, it would manage to form the haustorium between their roots (Lu et al. 2014). Haustoria formed under root association between sandalwood and host plant showed varied growth performance of sandalwood.

The presence of host plants in sandalwood cultivation is advisory because of their role as sources of K, P, Ca, and Na, even N, and C (Lu et al. 2013; Teixeira et al. 2016). The present study was revealed on S.album species which are geographically distributed in S.Pudur, Sivaganga of Tamilnadu, India. To understand the plant growth promoting and pathogenic microbes, which are surrounded around the soil, we need to study the *S. album* rhizosphere micro biome community. Bacteria are the most abundant of all the rhizospheric micro biota, and many are known to promote plant growth (Antoun et al. 2005; VanLoon, 2007).The present study made an effort to understand the diverse and complex bacterial communities present in the rhizospheric soils of S. album. 16S rRNA sequence data revealed 446OTUs assigned to different bacterial species colonizing the rhizosphere of *S. album* species studied. Analysis of these OTUs showed that Acido bacteria has the most significant number of rhizo bacterial communities

present in *S. album* phyla were studied here. Besides this, alpha diversity analysis also predicted for *S. album* sample. Phylum level distribution studies identified the dominance of Actino bacteria, Proteo bacteria, Acidobacteria, Chloroflexi, Firmicutes, Nitrospirae, Gemmatimona detes, OD1, Armatimonadetes, Planctomycetes, Bacteroidetes, WS3,Cyanobacteria and Spirochaetes. Many of them were reported to be present in the *S. album* rhizosphere (Bing et al. 2022). The 16S rRNA gene sequence analysis had helped to identify the top twenty genera (Acetobacter, Lactobacillus, Pseudonocardia, Kribbella, Iamia, Streptomyces, Virgisporangium, Mannheimia, Mycobacterium, Bradyrhizobium, Rhodoplanes, Agromyces, Bacillus, Mesorhizobium, Balneimonas, Kaistobacter, Nitrospira, Candidatus, Cellulomonas and Pasteurella).Out of these 20 genera, most of the genera were found to be capable of fix nitrogen in *S.album* and other plants. Acetobacter is plant growth promoting Rhizobacteria (PGPR) provided a significant increase in shoot and root length and biomass (Majeed et al. 2015). In our study Aceto bacter genera shows high abundance for sandal tree growth. Azoto bacter genus is involved in atmospheric nitrogen fixation in different crops (Jiménezetal.2011). It is hard to identify and classify most bacteria in culture because of their morphological similarities. But, culture-independent methods, such as 16S rRNA sequencing, are highly efficient, cost-effective and provide accurate identification and classification of rhizo bacteria. More recently, strains of Bacillus, Pseudomonas, Glomus and others have been commercialized. The use of bacterial taxa in plant production has been reviewed previously for Bacillus (Borriss, 2011), Pseudomonas (Santoyo et al. 2012; Sivasakthi et al. 2014), Actino bacteria (Shivlataetal.2017) and Lactobacillus (Lamont et al. 2017). In addition, Acetobacter was also been shown to enhance crop production (Babalola, 2010). In our previou sstudies, we observed the occurrence of Proteo bacteria, Acidobacteria, Actinobacteria, Firmicutes, Bacteroidetes, Bradyrhizobium and Gemmatimonasin the *S. album* rhizosphere (Bing et al. 2022). Some genera, such as Bacillus and Pseudomonas known for their plant growth promoting (Ma et al. 2010; Ma et al. 2011; Wani et al. 2010) and nitrogen fixing properties, were found to be enriched in the *S. album* rhizosphere. Community composition analysis of 16SrRNA sequenced at a helped to track phylum and genus level distribution of rhizo bacteria of *S. album* species studied. The characterization of these bacteria colonizing the *S. album* rhizosphere will be beneficial to improve *S. album* tree productivity.

 Diversity among these bacteria was revealed by alpha analyses. Genera Bacillus, Pseudom on as and Strepto myces are well known for plant growth and plant disease suppression activities in other crops (Amna et al. 2020; Chandra et al. 2020; Jiao et al. 2021). Compared to previous studies Acido bacteria, Actino bacteria and Firmicutes are higher abundance at genera level in *S.album* microbiome(Bing et al. 2022). Overall, the dominant genera identified in this study are known to fix atmospheric nitrogen, facilitating to plant growth. A sandal tree can grow without the need of the host for their growth. To prove this concept we tried our experiment into three parts which was discussed above in the experimental setups. The available potassium (K) and phosphorus (P) plays important role in Bagaldhara plantations for enhancing the height and girth growth of sandal seedlings (Das et al. 2018).According to the previous report we have done our experiment without host. Instead of providing host, we applied bio fertilizers for their growth. Compared to sapling growth with host, using of only bio fertilizers shows good growth in morphology when compared to with host. Chemical elicitors are used as a treatment in one year and two years old sandal saplings to analysis the growth parameters (Yuan Li et al. 2021). Instead of using chemical elicitors our experiment carried out with Actino bacteria culture for their growth promotion. Compared with overall experiments culture treated saplings shows good morphology results for both one and two year old sandal saplings.

CONCLUSIONS

The rhizosphere microbial community is an important player in the plant-soil eco system. The approach used in this work let us recover a total of 9,038 communities. The sequencing data analysis of the V3-V4 region on the Illumina showed distributed over 15 phyla, 53 genera, and 8species. Our study is to establish a *S. album* rhizosphere having the highest relative abundance offive major phyla, Actinobacteria, Proteobacteria, Acidobacteria, Chloroflexi and Firmicutes was found to be the dominant flora in the rhizosphere soil of S.album during growth. The top-ranked communities are concerning as growth promotion in S. album. The genera identified in this work are part of the microbiome of *S. album* identified in other research works. Filling the

significant knowledge gap on soil nutrients and microbiota of *S. album* interactions is critical for exploiting these beneficial microbes for sustainable sandal tree cultivation. According to the soil nutrients morphology analysis report, the more organic carbon and macronutrients (N, P, and K) the soil contains, the better the sandalwood seedlings develop (both in height and girth) and survive without the host. Actinobacteria culture treated sandal sapling show higher height and girth when compared to soil nutrients. As per our report proves that a sandal sapling can grow without host when it is treated with culture for their growth.

Author contributions
NSB performed the lab work under the supervision of VRK. MD did the statistical analysis. All authors contributed to interpret the results, write and revise the manuscript critically. All authors agreed with the final version of the manuscript.

Declaration of competing interest
The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability
Data will be made available on request.

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Table. 1 Soil physico chemical properties of *Santalum album*.

S.No	Properties	Values
1	pH	5.4
2	Bulk Density	$1.34 Mgm^{-3}$
3	Water Holding Capacity	15.6%
4	Moisture Content	13.7%
5	Electrical Conductivity	$0.14 dsm^{-1}$
6	Organic Carbon	6.3%
7	Available Nitrogen	91.6 mg/kg
8	Available Phosphorus	$11.00 kgha^{-1}$
9	Available Potassium	$72.0 kgha^{-1}$
10	Available Sulphur	$5.9 mgkg^{-1}$
11	Calcium	$5.9 mgkg^{-1}$
12	Magnesium	$3.86 kgha^{-1}$

Table 2 Growth Data of Sandal tree with host(neem)as on March 2021 and 2022.

No.	ar of Plantation	With Host (Neem Tree)		
		Height(cm)	al Grith(cm)	No. of. Leaves
1.	20-2021	156	8	4
2.	20-2022	150		6

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Table 3 Growth Data of Sandal tree with Actino bacteria culture treated seeds + Bio fertilizers without host plantation as on March2021 and2022.

S.No.	Year of Plantation	Actino bacteria treatment (Sandal Seeds + Bio fertilizers)		
		Height(cm)	Basal Grith (cm)	No. of. Leaves
1.	2020-2021	214	20	8
2.	2020-2022	196	16	10

Table 4 Growth Data of common Bio fertilizers applied on sandal tree without host as on March 2021 and 2022.

S.No.	Year of Plantation	Bio fertilizers		
		Height(cm)	Basal Grith (cm)	No. of. Leaves
1.	2020-2021	180	8	6
2.	2020-2022	176	6	8

Fig.1. Location map of S.Pudhur in Sivaganga District, Tamilnadu	**Fig.2. Sequence length distribution for *S.album* rhizosphere soil.**
Fig.3. Alpha diversity for *S.album* rhizosphere soil sample.	**Fig.4.Rare faction curve.**
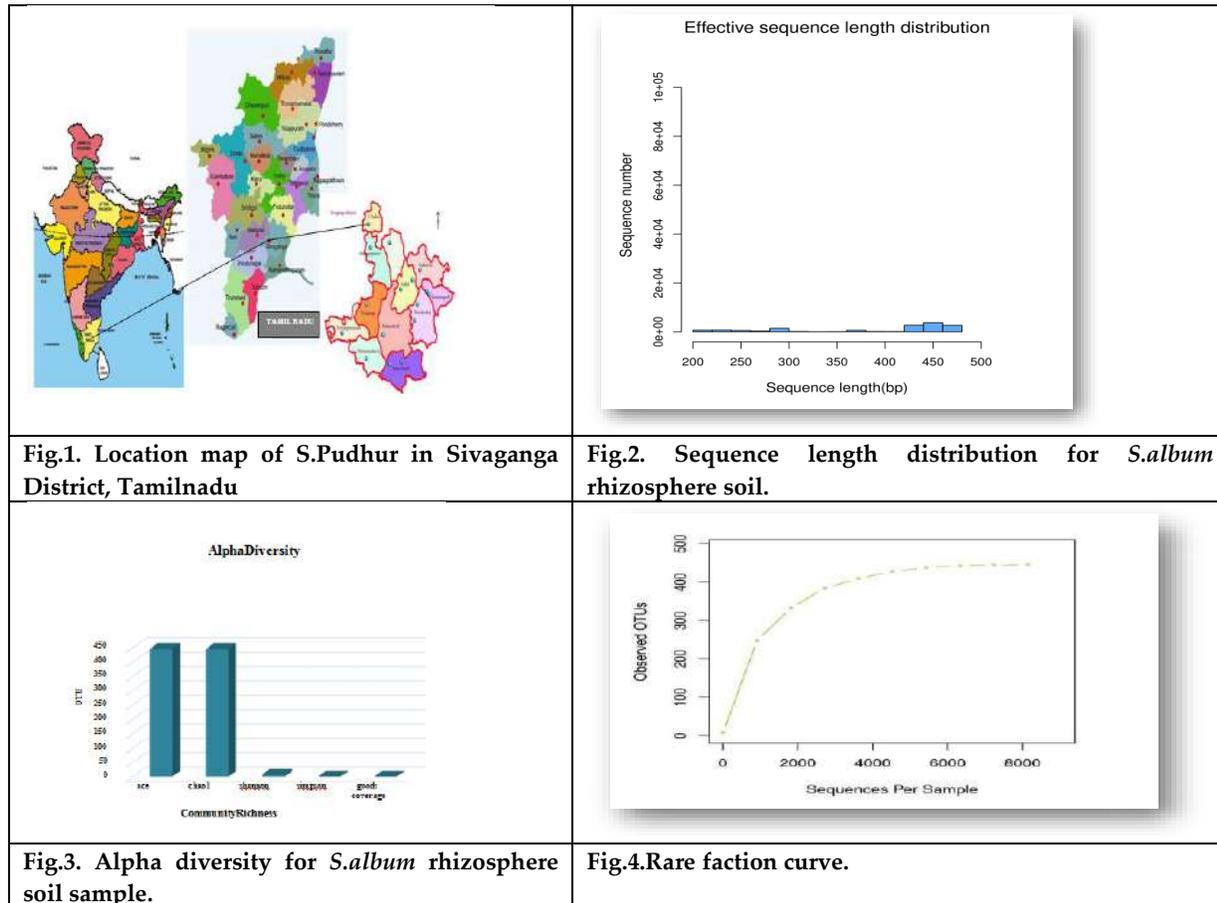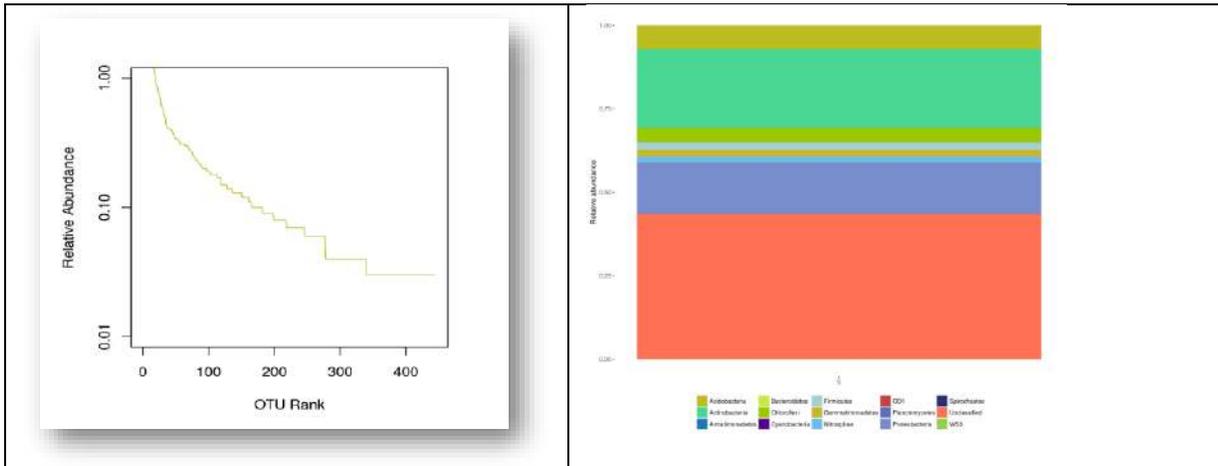
| Fig. 5. Rank abundance curves | Fig. 6. The relative abundances of *Santalum album* at Phylum levels. |
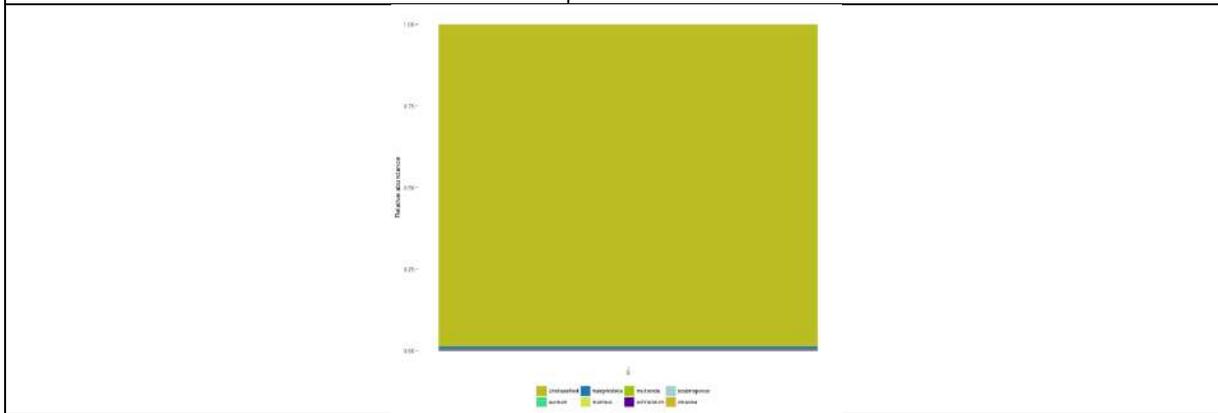
Fig.7. The relative abundances of *Santalum album* at Species levels.

RESEARCH ARTICLE

Phytoremediation of Dye Contaminated Soil by *Leucaena leucocephala* and Growth Assessment of *Eleusine coracana* in Remediated Soil

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ABSTRACT

This study uses a simple green chemistry approach to develop the Leucaena leucocephala seeds (LlSs) as a potential dye degrader. The Namakkal district contained soil that had been contaminated by textile effluent. On both control and dye polluted soil, various physic-chemical characteristics such as N, P, and K, as well as electrical conductivity, were measured above the standard permissible level, indicating high pollution. A UV-Vis spectrophotometer was used to compare the eluted dye concentration to its initial concentration. LlSs decreased BOD to 280 mg/l, COD to 698 mg/l, and Nitrate to 89 mg/l. LISs were mixed with vat dye (VD) spiked soil to assess *Eleusine coracana* seed germination compared with control soil. LISs absorbed the Vat dye and form the LIS-VD complex. *Eleusine coracana* seed germination was good in LISs mixed soil when compared to the control soil. The functional groups bonded with LlSs in remediated soil were screened as C-O,-NO$_2$ -OH, C-O-C, and C=C, etc. LlSs exhibited well potential treatment of textile effluent contaminated soil.

Keywords: *Leucaena leucocephala*, *Eleusine coracana,* Vat dye, Phytoremediation

INTRODUCTION

The health of the soil is essential to the development of vegetation, the preservation of the natural biota in the area, and ultimately the return of the ecosystem to its original state. With the knowledge that the soil contains biological components necessary for ecosystem function, soil health is defined as the soil's continued capacity to function as a vital living system within territorial limits. These activities can boost the biological production of the soil, protect the local water and air quality, and have positive effects on the health of nearby plants and animals(Agarwal *et al*, 2004).

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Human actions including industrialization, urbanization, and other disruptions to the natural terrestrial ecology are the main causes of soil contamination. Examples of this kind of pollution include broken underground storage connections, the use of pesticides, the seepage of contaminated surface water into subsurface layers, the disposal of oil and fuel, landfill leaching, and the direct release of industrial wastes into the ground(Dehpour *et al.*, 2009).The textile industry also generates a large variety of chemicals that pose a waste solution and disposal problem because they are not always contained inside the finished product. High aromatic chemical content and low biodegradability in fabric dyes and dye intermediates have been identified as major sources of pollution(Ameta *et al.*, 2003), and nearly 10%–15% of the dye is lost during the dyeing process and released into the wastewater, which is a significant source of pollution. Water is used extensively in the dyeing industry for cloth finishing and dyeing. Wastewater from fabric dyeing and dye-synthesizing processes are examples of poorly treated wastewater that contains natural dyes.Garg and Kowshik (1998) found that these wastewaters had a vibrant hue, significantly variable pH, high COD, and bio-toxicity. The fabric industry's dye pollution is a primary source of environmental contamination. It is estimated that at some point throughout the dyeing and finishing processes, 15% of the world's total dye production is lost and ends up in fabric wastewater.

Azo dyes, which comprise one or more nitrogen to nitrogen double bonds (-N,N–) and make up a significant portion of dye colorants, are widely used in the dyeing industry today. They are resistant to aerobic degradation and can degrade into potentially carcinogenic aromatic amines in anaerobic environments. Initha *et al.*, (2013) suggested that a growing green technology called phytoremediation uses plants to break down a few harmful chemicals found in soils, sediments, groundwater, floor water, and the atmosphere. It can be applied as a standalone remediation method or as a component of a larger site control solution that includes a variety of remediation methods. Evidently, plants have grown at contaminated waste sites; these plants were planted for aesthetic purposes or to stabilize the area (Vanaja *et al*, 2014). Many kinds of contaminants are currently treated using it, including radionuclides, insecticides, explosives, heavy metals, and petroleum hydrocarbons. Leucaena leucocephala has earned the moniker "miracle tree" for its widespread success and long lifespan. Contour planting has been promoted recently as a way to preserve soil fertility and conserve small-scale tropical farming buildings (Jayanthy *et al*, 2014). L. leucocephala is a colonizing plant that has spread throughout several locations, some far outside of the tropics, and that must adapt to a vast range of locations that may be more or less frost-free. At a temperature of 25–30 0C, L. leucocephala grows. In this work, we use a large number of falling seeds for the purpose of dye degradation. The purpose of the experiments is to evaluate the germination and growth potential of (*Eleusine coracana*) finger millet, as well as the phytoremediation potential of L. leucocephala for soil contaminated with dyes.

MATERIALS AND METHODS

Collection of Soil Sample Namakkal area is located with many dyeing industries and the textile dyeing process involves large volumes of water mixed with dyes. The untreated textile wastewater is being discharged, contaminating the soil around the dyeing units. Plant growth is sparse and thus this soil was identified for the study. Five locations were selected in the latitude of 11.229592 and the longitude of 78.171158**.** The soil was taken (100 kg/ha) at a depth of 0–25 cm. Composite replicates were prepared, air-dried, sieved, and stored for further analysis. In the same area unpolluted soil was used as control.

Phytoremediation The *Leucaena leucocephala* seeds (LISs) were collected in Namagiripet, Rasipuram, Tamil Nadu. *Eleusine coracana* was obtained from ICAR-Krishi Vigyan Kendra Namakkal. *L. leucocephala* seeds(LISs) were taken separately for the phytoremediation analysis. No binding agent was used to study the exact nature of *L. leucocephala* biomass.

Soil Characterization

The soil collected was cleaned of debris, shade dried, sieved to a uniform size, and used for further studies. The initial soil profile was done and the soil characteristics like N, P, K, pH, electrical conductivity, lime, and texture were assessed before and after remediation.

Dye degradation Kinetics

Vat dye was obtained from Sigma Aldrich Chemicals. The stock solution of Vat dye (1 mg/ml) was made. The stock solution was diluted with deionized water to create the various concentrations of Vat dye (100, 200, 400, 500, and 600 μg/ml). One gram of seed was put to two milliliters of dye, and the LISs and dye were combined in a 1:2 ratio. For full degradation, the combinations were well mixed and allowed to sit at room temperature. The reaction mixtures' absorbance was measured using spectrophotometry at a maximum wavelength of c max 450 nm every 24 hours. The Vat dye was allowed to completely decolorize during the incubation period. The percentage decolorization was calculated by using the following equation:

Decolorization (%) =$100(D_0 - D_1)/ D_0$

Where D_0 is the initial absorbance of the dye solution and D_1 is the absorbance after incubation at a specific time. All determinations were carried out in triplicate.

Evaluating the *Eleusine coracana (Ragi)* Seed Germination Before and After Remediation of Dye Contaminated Soil

The study's soil control was ground into a fine powder and filtered through sieves with a mesh size of 0.500 mm and 0.071 mm. Sieves with a mesh size of 0.071 mm were also used to filter potassium bromide of spectroscopic grade. Three grams of LISs powder were added to 100 grams of VD-spiked soil. Next, the germination of E. coracana seeds was evaluated in relation to the control group. *Eleusine coracana*'s capacity for germination and growth was examined in order to achieve this. As growth-inducing factors for *Eleusine coracana*, the study assessed the biometric levels of plant growth, which were then followed by biochemical and stress indicators.

Spectral Studies With Soil and Remediating Plant Material

To 100 g of dye spiked soil was added 3 g of LISs powder, mixed well, and placed on a vertical shaker for 24 h. After 24 h the corresponding solutions were equilibrated and then filtered. About 20 ml of the clear filtrate was digested with triple acid was used for Fourier Transform Infrared Spectroscopy (FTIR) analysis to compare the dyeing binding capacity with LISs and soil using Thermo Nicolet FTIR Nexus spectrometer coupled with DTGS (deuterated tri-glycine sulfate) detector.

RESULTS AND DISCUSSION

Physicochemical Characterization Of Dye Contaminated Soil And Control Soil

The physical characteristics of the soil, such as pH, electrical conductivity, and texture, remained unchanged, according to soil analysis performed on both contaminated and unpolluted soils (Table 1). Both contaminated and uncontaminated soils had different chemical compositions. In comparison to unpolluted soil, the dye-polluted soil had a higher lime content. The macronutrients, including potassium and phosphorus, were severely impacted. There was a reduction in the phosphorus concentration from 51.6 to 25 kg/ha. In a similar vein, the potassium concentration dropped from 983 kg/ha to 140. While iron and zinc dropped from 439.4 to 20.77 pm and 2.2 to 1.95 ppm, micronutrients like copper and manganese increased from 1.07 to 2.86 pm and 2.03 to 3.77 ppm. Therefore, dye contamination in soils can impact the macro and micronutrient contents of soils, according to examination of soil characteristics. According to Garg and Kowshik (2007), the soil is a complex living system whose properties determine how well it can be cleaned up and what kind of remediation is best.

Dye Degradation Kinetics

The complete decoloration of Vat dye was obtained on day 6 at 200 µg/mlof Dye concentration (Fig. 1). LlSs were degraded 89.4% of vat dye after incubating for 6 days at 400 µg/ml of Dye concentration. This result reveals that the LIPs-VD complex was formed by the action of seed absorption of Vat dye. This Vat dye degradation by Candida sp. This was confirmed by Abioye *et al*. 2015.

Evaluating the Growth Potential of *Eleusine coracana (Ragi)* before and After Remediation of Dye Contaminated Soil

The Phytoremediation phase was confirmed by establishing the seed germination study. The optimum ratio of biomass to soil was 1:100 ratio. This ratio was found to be optimum for remediation and involved the assessment of biometric levels of plant growth followed by biochemical and stress parameters as inducers of growth of *Eleusine coracana.* LlSs reduced the BOD from 1,365 mg/l to 280 mg/l, COD from 3,532 mg/l to 698 mg/l while the Nitrate was reduced from 225 mg/l to 89 mg/l. A study was conducted and compared to a reference control to determine the proportion of ragi that germinated when grown on soil tainted with dye and treated with L. leucocephala biomass powder. The third day following seeding, when maximal activity takes place, is when percentage germination was calculated. On the thirtyth day following germination in the soil, plant biomass was evaluated. displays the results of germination. Soil tainted with dyes affects seedling growth more than stabilized and remediated soil. *Eleusine coracana* germination rate increased as a result of L. leucocephala biomass treatment, which mitigated the effects of dye-contaminated soil. In *Eleusine coracana*, the application of L. leucocephala biomass as a phytoremediator increased the rate of germination and encouraged root induction. *Eleusine coracana* branch development and germination were reported by Initha *et al*. (2013). The germination of seeds is compromised by an excessive build-up of dye in the cotyledons, which interferes negatively with the mobilization of mineral and organic reserves. This modifies the physiological and biochemical processes of the developing plant and impacts the growth of the seedlings. In their 2021 study, Ekanayake *et al*. examined the effects of different dye concentrations on phytoremediation trials.

Spectral study for *L. leucocephala* biomass by FTIR

FTIR was carried out (Fig. 1) with LlSs remediated soil which revealed the presence of the functional groups bonded within remediated soil like amines (3351 cm^{-1}), alkanes (C-H; 2430 cm^{-1}), alkenes (-C=C-; 1636 cm^{-1}), ethers (=C-O-; 1000 cm^{-1}) and, (C-Br;517 cm^{-1}). These groups could be responsible for the binding capacity of the dye to plant material on phytoremediation. Swapnil *et al*. 2018, was reported that vat dye degradation studies were done by Infrared spectroscopic analysis.

CONCLUSION

The present study was done to understand the phytoremediation potential of *L.leucocephala* for the dye-contaminated soil. This was assessed on the germination and growth potential of *Eleusine coracana*(ragi). A pilot study was carried out with a varying mass of LIPs and the optimum ratio for dye contaminated soil was observed to be 3 g of plant biomass per 100g of soil.It was found that stress markers like proline methylglyoxal content of leaves and roots were increased significantly in a plant grown in the dye contaminated soil than in remediated soil using LIPsbiomass. The above observation indicates the protective effect of LIPs biomass against abiotic stress caused by dye contamination. It can function as an organic photo stabilizer that degrades naturally for dyes like Vat dye in a variety of colors. According to the study, it can clean up contaminated soil up to a 50% maximum, and ragi can be grown on the cleaned soil.

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Declaration of Conflict of Interest
No conflict of interest

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Table 1: Physico-chemical characterization of dye contaminated soil and control soil

S.NO.	Particulars	Dye contaminated soil (100kg/ha)	Control soil (100kg/ ha)
1	P^{H}	8.84	8.4
2	Electrical conductivity (ds/m)	0.28	0.26
3	Texture	CL	CL
4	Lime	C	SC
5	Available N(kg/ha)	199	200
6	Available P (kg/ ha)	25	51.6
7	Available K (kg/ha)	140	983
8	Copper (PPM)	2.86	1.07
9	Manganese (PPM)	3.77	2.03
10	Iron (PPM)	207	439.4

Table 2: Biometry assay for Contaminated and remediated soil on seed germination and seedling growth of *Eleusine coracana***.**

Test Parameter	Control	Vat dye		Reactive dye	
		Contaminated soil	Remediated Soil	Contaminated soil	Remediated Soil
Germination (%)	100	50	90	51	88
Root Length (cm)	7.5 ± 1.3	3.6 ± 0.8	6.5 ± 1.5	3.8 ± 1.0	5.9 ± 1.4
Shoot Length (cm)	18.5 ± 0.8	10.8 ± 0.9	15.6 ± 0.7	9.1 ± 1.3	17.4 ± 1.0
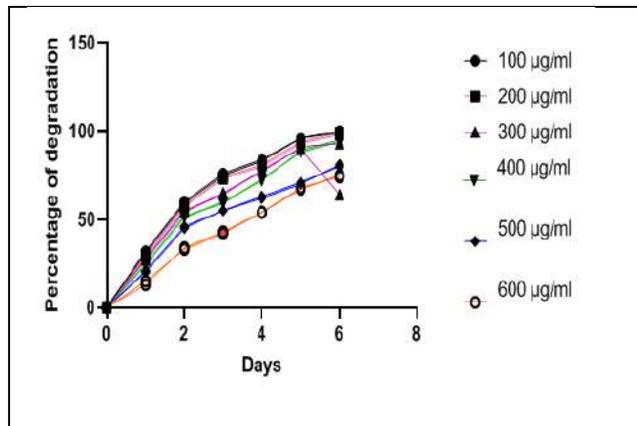
Figure 1: Dye degradation Kinetics against LIPs	**Figure 2: FTIR analysis for remediated soil by LIPs**
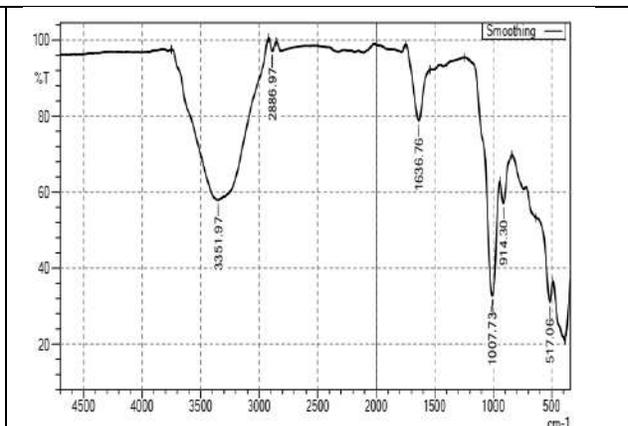
REVIEW ARTICLE

A Review on Natural and Chemical Whitening Agents

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ABSTRACT

The allure of a pale complexion is nothing new; people of all time were concerned with hyper pigmentation and other skin problems and were always looking for ways to look fair. Nowadays voluntary de pigmentation is more common and people use herbal as well as chemical ways for skin lightening. This review article highlighted the skin whitening agents that can be obtained naturally and chemically. Many substances have compounds that have the property of tyros in a se inhibition and thus leading to skin whitening. The widely reported adverse effects of synthetic ingredients encourage the development of using herbal ingredients. Many compounds described in the review article are used for pigmentary disorders such as melasma and post inflammatory hyper pigmentation. In this review we present an overview of skin whitening agents that may decrease skin pigmentation.

Keywords: Anti tyrosinase activity, skin lightening, melanin, antioxidant activity

INTRODUCTION

The allure of a pale complexion is nothing new; people of all time were concerned with hype rpigmentation and other skin problems and were always looking for ways to look fair. Many people in sub-Saharan Africa use herbal tea prepared from local plants (*Tephrosia vogelii, Mirabilis jalapa, Phytolacca dodecandra*) to lighten the complexion of girls for special occasions. The use of preparations to lighten skin tone is referred to as "voluntary de pigmentation. Nowadays voluntary de pigmentation is more common and people use herbal as well as chemical ways for skin lightening. Melanocytes are the cells that produce the pigment melanin, the pigment which give colour to the skin. They are situated on the basal layer which separates dermis and epidermis. Approximately 36 keratinocytes surround one melanocyte and together, they form epidermal melanin unit. The melanin is produced in the melanosomal compartment inside the melanocyte and is transported to keratinocytes via dendrites.

The melanin pigment is a polymer synthesised from the amino acid L-tyrosine. L-tyrosine is converted to dopaquinone by the enzyme tyrosinase. This reaction continues spontaneously via dopachrome to the monomeric indolic precursors (5,6-dihydroxyindole and 5,6 dihydroxyindole 2-carboxylic acid) of the black-brown pigment eumelanin. Tyrosinase related proteins (TRP-1), dopachrome tautomerase (TRP-2) and many other enzymes also play an important role in melanogenesis. Upon reaction with cysteine, dopaquinone forms 2- or 5-S-cysteinyldopa that generates the benzothiazine precursors of the red/yellow pheomelanin polymer. In general, a mixed type of pheo- and eumelanin polymer is produced and deposited onto the melanosomal matrix proteins. Considering different people have different skin and hair colour, the composition of the mixed melanin can be regulated in many different ways. But altered production of cutaneous melanin can result in hyper pigmentary conditions, like melasma, post inflammatory hyperpigmentation, freckles or depigmenting conditions, like vitiligo. Both can affect the life of people to a vast extend. Many skins whitening agents mainly targets the enzyme tyrosinase for de pigmentation [1]. There are four types of tyrosinase inhibitors competitive, uncompetitive, mixed type and non-competitive inhibitors [2]. The nature of tyrosinase inhibition can be disclosed by measuring enzyme inhibition kinetics using Line weaver-Burk plots with varying concentrations of L-DOPA as the substrate. Tyrosinase inhibitors mainly show reversible inhibition. Irreversible inhibition causes inactivation of enzyme by altering the active site of enzyme or by conformational changes to the protein molecule. Suicide inhibition mechanism is another way of irreversible inhibition. An example of suicide inhibition is inhibition of tyrosinase by, two 8-hydroxy iso flavones iso flavones isolated from soy germ koji.

Natural agents

Mangosteen

Mango steen having scientific name *Garcinia mangostana* L. is a tropical queen of fruits, belonging to the family of Clusiaceae commonly found in throughout India and Southeast Asia, such as Indonesia, Malaysia, Myanmar, Philippines, Sri Lanka, and Thailand. The peel of mangosteen fruit contains phenolic compounds like tannins, flavonoids, xanthones, and other bioactive substances which have medicinal properties (Pothitiratet al., 2009). The mature mangosteen has higher contents of phenolics, flavonoids, and tannin significantly than the young ones. Xanthones in mangosteen peel has skin lightening property. α-mangostin, β-mangostin, and γ-mangostin are the most abundant xanthones present in the pericarp of the mangosteen (Chen et al., 2008; Pedraza-Chaverríet al., 2009; Zarena and Sankar, 2011). Researches shows that acetone with time extraction of 36 hours is the best solvent to extract mangosteen among solvents like methanol, ethanol, acetone, hexane, ethyl acetate, acetic acid, and aquades tat different times (24, 36, and 48 hours).But it was found that ethyl acetate extract the highest concentration of α-mangostin, followed by dichloromethane, ethanol, and water [3]. _Wahyu Widowati et al, characterized the magosteen peel physically and chemically, the tyrosinase inhibitory activity of Mangosteen peel measured. It was found that gamma-mangostin strong anti tyrosinaseactivity (IC50 50.35 μg mL–1) and the activity increases as follows mangosteen peel extract <garcinone D <alphamangostin <garcinone C < gamma-mangostin. This study shows that gamma-mangostin may serve as potential skin whitening agent [4]. Puay Luan Tan et al, formulated and evaluated novel herbal face creams containing mangosteen peel extract that was standardized to 10% alpha-

mangostin. The Mangosteen peel extract was weighed and incorporated into the cream bases and evaluated. Kojic acid (0.67 _g/mL to 10.66 _g/mL) was used as a positive control for testing tyrosinase inhibitory activity and it was found that Mangosteen peel extract (IC50: 1.603 _g/mL) strongly inhibits tyrosinase enzyme as compared with kojic acid (IC50: 3.57 _g/mL).[5]

Rosmarinic acid

Rosmarinic acid (RA) is an ester of caffeic acid and 3,4-dihydroxy-phenyllactic acid. It is anatural polyphenol contained in Lamiaceae herbs, such as **Perilla frutescens**, lemon balm mint, sage and sweet basil etc. Polyphenols are aromatic and slightly bitter-tasting compounds in vegetables, fruits and herbs [6]. Rosemarinic acid originates from aromatic amino acids, phenylalanine, and tyrosine, respectively and has antibacterial, antimutagenic,anti-allergenic, antiviral, antioxidant, antityrosinase and anti-inflammatory properties. In Ortensia I. Parisi et al,an innovative polymeric antioxidant was developed by the conjugation of dextran (DEX) and rosmarinic acid and inhibition of tyrosinase activity was determined by using L-tyrosine as substrate. All the results indicated that the polymeric conjugates can inhibit tyrosinase reaching inhibition percentages higher than 95% and suggesting the application of DEX-RA as a skin-whitening agent. To evaluate the whitening and lightening efficacy a placebo-controlled clinical-instrumental study was carried out on 20 female subjects with dull skin complexion and dark spots on the face and the result shows that the formulation reduces the dark spot staining and increases the skin radiance Dark Spots Intensity, Skin Lightness/Radiance, Reduction of Dark Spots and Red Component of the Skin Colour was evaluated. The clinical evaluation of the reduction of dark spots appearance and skin brightness was performed by the dermatologist and all the results indicated that the polymeric conjugates can inhibit tyrosinase reaching inhibition percentages higher than 95% and suggesting the application of DEX-RA as a skin-whitening agent. Furthermore, the active polymer, shows a long-lasting efficacy and improved performance compared to the free antioxidant [7]. Karina B. Oliveira et al, studied the melanogenic activity promoted by rosemarinic acid, and its contribution in the melanogenic effects promoted by a fluid extract and an aqueous extract prepared from dried sage leaves. The study suggests that sage extracts and RA interfere in melanogenesis at cellular melanin levels depending on their concentration. RA showed a dual behaviour on melanogenesis, acting as stimulator of melanin synthesis and cellular tyrosinase activity at low concentrations, and as an inhibitor at high levels indicating rosemarinic acid as a potential therapeutic agent for treating diseases related to skin pigmentation [8].

Cassia auriculata

Cassia auriculata Linn, Family: Fabaceae (Caesalpiniaceae) Its flowers are, bisexual with irregular and bright yellow, the pedicels glabrous and 2.5 cm long and consist of 5 sepal and 5 petals. Mostly found in India. It mainly used in Ayurveda and Siddha systems of medicine because its flower unripe fruit leave stem etc used for diabetics, anthelminthic, leprosy, conjunctivitis, and skin diseases. It is also called as *Tanners Senna*. *C. auriculata* is also called "kalpa herbal tea", major components of a beverage [9] Constituents: 3-O-Methyl-d -glucose (48.50%),α- Tocopherol-β - D-mannoside (14.22%), n-Hexadecanoic acid(3.21%), 13-Octadecenal, (Z)(2.18%), resorcinol(11.80%) and 1,2,3,4-Tetrahydroisoquinlin-6-ol-1-carboxlic acid(1.98%). Flower consists of constituent: terpenoids, tannin, flavonoids, saponin, cardiac glycosides and steroids. Ethanolic extract of Flower of *C. auriculata* as antibacterial, anti-oxidant, anti-inflammatory action [9] Antibacterial activity: Antibacterial activity against the microorganism such as *Escherichia coli, Staphylococcus aureus, Salmonella typhi, Bacillus subtilis, Pseudomonas aeruginosa, Klebsiella pneumoniae, Vibrio cholerae* and *Shigella dysentrae* and maximum inhibitory action seen in organisms except *Pseudomonas aeruginosa* and *Klebsiella pneumoniae*. The minimum inhibitory concentration (MIC) ranged between 12.5 mg/mL and 75mg/mL depending on microorganism and various extract [10]. Anti-oxidant activity: ethanolic or methanolic extract of flower of *C. auriculata* show antioxidant action, determined by DPPH assay with E50 value =19,99 microgram per ml compound by 2 positive control BHA= 23.12 microgram per ml [11]. Melanin is a type of pigment that present in our body which determine the human skin and the process of synthesis is called melanogenesis and it start from L dopa. Tyrosinase, the enzyme reason for darkening of skin. so, target is to inhibition of tyrosinase. Inhibition of tyrosinase byhydromethanolic extract of flower of *C. auriculata* is determined by antityrosinase assay with an IC50 value of

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42.49microgram per ml and compound by positive control, ascorbic acid (IC50 -33.7) shown by Mayuri Tharanga *Napagoda* et al [11]

Aloe vera

Aloe vera having scientific name *Aloe barba densis* Mill with fam: Asphodelaceae is a flowering succulent plant. It is a traditional type medicine used mainly for skin diseases. Now it also used in food, cosmetic as cream, lotion etc. It also has a purgative action, mainly found in tropical and sub-tropical countries. [12]These A. vera-containing substances consist of 99.5% water and 0.5% active ingredients, including vitamins, polysaccharides, phenolic compounds and organic acids. The gel form present in aloe vera as variety of activity includes anti-viral, anti-bacterial, anti-inflammatory, anti-cancer, antiallergic, anti-diabetic etc.[13]The dagger-shaped leaves are the most used part of the plant traditionally as medically for various treatment include encephalitis, wound healing, diabetics. Eye infection, AIDS etc but also A. vera extract and its active constituent aloin has skin lightening property. Aloe vera extract are potent inhibitors of the enzyme tyrosinase, which plays an important role in melanogenesis by inhibit l-3,4-dihydroxyphenylalanine (L-dopa) oxidation by mushroom tyrosinase. Inhibition of tyrosinase by aloin indicates that this compound could be useful for the treatment of hyper pigmentation disorders. It also has anti-inflammatory and anti-bacterial properties.It also contains a pain-relieving compound called carbo xypeptidase, which gives us the soothing sensation we have every time we apply Aloe Vera [14].

Mr. Jeon Gibeom et al explained about the leaf skin of A. vera fermented by *L. plantarum* BN41 newly isolated from Kimchi and this fermented vegetable inhibits tyrosinase activity and skin melanogenesis was used to develop a natural cosmetic ingredient Aloesin (natural hydroxymethyl chromone), is not abundant mainly found in outer layer of skin leaves. It is an active constituent in aloe vera was also used in skin whitening cosmetic ingredient because of competitive tyrosinase inhibitor and also effective to wound healing process [15]. Mr. Mikel Añibarro-Ortega shown thatthe leaf of aloe vera contain phenolic content and the flower extract contain apigenin glycoside derivative which is effective against *Pseudomonas aeruginosa* (MIC = 0.025 mg/mL and MBC = 0.05 mg/mL) so flower extract is also good for antityrosinase activity (IC50 = 4.85 mg/mL). [16] Uses of aloe vera includes, it soothes sunburn(it contain polysaccharides, which helps in encouraging skin repair and new skin cells to set up shop), Moisturizes the skin because it contains mostly (95%) of water, it hydrates the skin with no greasy feeling, it treat mouth sores, slow down ageing of skin, it fight acne and fades blemishes, relieving from skin irritation, cleanser of skin, exfoliate skin, The salicylic acid in Aloe Vera gel can act as an exfoliator by gently sloughing off the dead skin cells.

Santalin

Santalin is a natural red constituent in the bark of Pterocarpus. Santalinus,Fabaceae family and genus Pterocarpus. These can be isolated from dried heart wood of *P. Santalinus*. It is to provide a natural extract showing an excellent whitening effect. Chemical constituent includes: Carbohydrates, flavonoids, terpenoids, phenolic compounds, alkaloids, saponins, tannins and glycosides and also contains specific bio active compounds like santalin A and B, savinin, calocedrin, pterostilbenes and petrolinus K and L. It is widely used in skin complexation and have tyrosinase inhibition action because of presence of 2 hydroxyl group in santalin, melanin biosynthesis inhibiting effect on melanocytes thereby lightening the skin colour and preventing pigmentation. It is to provide a natural extract showing an excellent whitening effect. The mode of inhibition by diphenolase activity and kinetic study. It is also used as refrigerant, astringent and sun protection agent'. Paste form santalin is useful for headache. In order to check the mechanism of santalin, melanogenesis process used B16F10 cell lines. santalin inhibited melanogenesis without any cytotoxic effects to B16F0 melanoma cells through down regulation of MITF, tyrosinase, TRP-1 and TRP-2.[17].

Anti tyrosinase action: It is determined by using UV visible double beam spectrophotometer in 475nm. The IC_{50} value of it was 15.21+- 0.326mM. so, it is in dose dependant manner, kojic acid is used as positive control IC_{50} value of it is 0.014Mm. shown by Hridya Hemachandran et al. [17] Measuring Tyrosinase Inhibitory Effect Using Mushroom Tyrosinase using 96 well plate in 490nm using a microplate to measure the inhibition rate against tyrosinase.,

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IC 50 value is the concentration of a substance that inhibits the tyrosinase enzyme activity by 50%. It also as anti-aging property, so as to prevent premature ageing of the skin and give a glowing, fair skin. Other uses of santal wood include, antibacterial agent, antidiabetic agent, anti-inflammatory agent, anti-oxidant agent, gastro protective, hepato protection and also have wound healing property. it is usually combined honey and applied to face as a face pack.

Turmeric

Turmeric having scientific name *Curcuma longa* Linn, family zingiberaceae has been used in Asia for thousands of years in ayurveda, siddha medicine, traditional Chinese medicine, unani medicine. In ancient years it was used as dye (colouring agent) and later for its supposed properties in folk medicine. Madras" and "Alleppey" turmeric are the two main commercial types of turmeric in India (Hima Gopinath et al, 2018) [18].Turmeric is a perennial herbaceous plant reached up to height 1m tall. Yellowish orange, aromatic rhizomes. The leaves are alternate, arranged in 2 rows and divided into leaf sheath, petioles, leaf blade. Mainly found in tropical and subtropical regions of Asia and Africa [19]. Chemical constituents such as, powder consist of 60–70% carbohydrate, 6–13% water, 6–8% protein, 5–10% fat, 3–7% dietary minerals, 3–7% essential oil, 2–7% dietary fibre, and 1–6% curcuminoids. The golden yellow colour of turmeric is due to curcumin. phytochemical components: diarylheptanoid, a class including numerous curcuminoids, such as curcumin, demethoxycurcumin, and bisdemethoxycurcumin. Curcumin constitutes up to 3.14% of assayed commercial samples of turmeric powder (the average was 1.51%); curry powder contains much less (an average of 0.29%). Some 34 essential oils are present in turmeric, among which turmerone, germacrone, atlantone, and zingiberene are major constituents.

Uses

properties of turmeric include, anti-inflammatory action, reduce dark circles, protection from sun damage and UV rays, protection from aging, and reduce stretch mark, anti-bacterial action, treatment for acne, soothes dry skin. Other uses like treatment for psoriasis, vitiligo, skin cancer, scleroderma etc. The essential oils may have antioxidant, anti-inflammatory and anti-nociceptive properties [18]. The curcuminoid compounds present in the turmeric improve skin properties such as hydration and sebum content and have properties like antioxidant, anti-inflammatory and skin-lightening agents. It is a polyphenol obtained from the rhizome of turmeric plant as constituent. Curcumin is major constituent of curcuminoid having skin whitening property by inhibit melanin synthesis [20]. Also, anti-cancer, anti-inflammatory, anti-bacterial, anti-fungal, and anti-oxidant activities and it showed 75-fold more potent anti-tyrosinase activity than arbutin and kojic acid was mentioned in Jesmin Akter et al [19]. Jesmin Akter et al showed that MeOH extract of *C. amada* were fractioned with water, n-hexane and EtOA but EtOA have strong inhibitory effect as compared to other. This MeOH extract of *C. amada* showed maximum mushroom tyrosinase inhibitory effect as compared to 3 species include *C.xanthorrhiza*, *C. aromatica* and C. zedoaria with 1c50 value of c. amada is 53.4 ± 2.7.(3). So, *C.amada* show effective tyrosinase inhibitor [19]. ADR topical use of curcumin cause Contact urticaria, Allergic contact dermatitis to turmeric or curcumin with positive patch tests has been reported. It has also been reported with tetra hydro curcumin. Also cause allergic and pigmented contact dermatitis with turmeric [18].

Honey

Honey is a natural product formed from nectar of flowers by honeybees having scientific name *Apis mellifera*, family: Apidae. It composed mainly of fructose and glucose, and containing proteins and amino acids, vitamins, enzymes, minerals, and other minor components. Honey as variety of function includes treatments against tinea, pityriasis, dandruff, dermatitis, psoriasis, haemorrhoids, anal fissure etc. and also as dressing for wound. Its activities include emollient, humectant, soothing action, retards wrinkle formation, keeps the skin juvenile and in hair it is used as hair conditioner, and regulates pH and prevents pathogen infections. So, it can be formulated into variety of formulation such as hydrating cream, ointments, tonic lotion cleansing milks, shampoos, and conditioners etc. Anti-oxidant property, antimicrobial property, anti-aging effect, anti-inflammatory [21] Treatment of wound healing: honey helps to kill a wide range of wound pathogens, such as methicillin resistant Staphylococcus

aureus *(*MRSA*)*, Staphylococcus aureus, E coli, Pseudomonas aeruginosa and Acineto bacter baumannii. It promotes re-epithelialisation and angiogenesis in in vitro models of wound healing [22]. Anti-oxidant property: Kanyaluck Jantakee *et al*, show anti-oxidant activity by DPPH assay of different variety of honey such as lychee, sunflower, coffee, polyfloraetc. and the highest antioxidant action shown by honey collected from nector of coffee flower of 86.20mg gallic/kg of honey collected from it. Lowest antioxidant activity by honey collected from lychee flower (5.93mg gallic/kg of honey. [23] Antityrosinase property: range= 22.71 ± 6.82 - 87.73 ± 5.33%.The highest activity of antityrosinase action shown by honey from manuka honey of 500.15mgkoji/kg honey. However, honey from coffee flower had highest tyrosinase inhibition action compared to other type.[23] Chemical agents

Hydroquinone

Hydroquinone or 1, 4 dihydroxy benzene is a white crystalline powder formed by hydrolysis of arbutin. Sources of arbutin include leaves of several plants, berries, coffee beans, teas extracted from berries, broccoli and the bark of the pear tree, red wine, wheat germ and diet cola. Hydroquinone actby inhibiting tyrosinase which in turn prevent the conversion of L-3,4- dihydroxyphenylalanine (L-DOPA) to melanin. It was found to have its skin lightening effect when the fur of guinea pig and cat were lightened on exposure. So in vitro and invivo test were done which proved thathy droquinone can inhibit tyrosinase. Hydroquinone is not a best agent to reduce the colour of melanin that is already deposited within epidermis or dermis. Since it inhibits DNA & RNA, it can only be used to retard or stop production of new melanin. So, hydroquinone can be used for conditions like melasma or post-inflammatory hyper pigmentation [24]. Clinicallyit can be used for the treatment of Chloasma, Solar lentigines, Freckles. Hydroquinone containing product is massaged on to the face (or other affected areas) 1 to 2 times a day for 3 to 6 months. If there are no results after 2 to 3 months, hydroquinone should be discontinued. It is essential to evenly apply hydroquinone over the entire face to prevent uneven pigmentation and use concurrently with sunscreen to protect from damaging UV light, which increases pigmentation. Skin whitening effect of hydroquinone gives maximum result when it is combined with retinoid and corticosteroid and the most widely used triple combination cream is composed of hydroquinone 4%, tretinoin 0.05%, and fluocinolone acetonide 0.01%.

 When hydroquinone is applied topically 35 -40 % is absorbed to systemic circulation, due to this reason pregnant women, breastfeeding mothers and children should avoid this drug. According to the USFDA tentative final monograph for over-the-counter skin-bleaching agents in 1982, safe and effective concentration of hydroquinone was considered to be 1.5–2%. On March 27, 2020, under the US CARES (Corona virus Aid, Relief, and Economic Security) Act it is now illegal to market over the counter hydroquinone products of any concentration. the main reasons behind the ban were the fear of hydroquinone causing permanent dis colouration and ochronosis. Other adverse effects of hydroquinone application are irritant or allergic contact dermatitis, post inflammatory hyper pigmentation, hypo pigmentation and nail dis colouration. Even though regulatory authorities set a limit for hydroquinone many commercially available creams have hydroquinone content more than the permissible limit this can lead to several adverse effects such as such as erythema, oedema, inflammation, sensitization, photosensitization and itching. Studies shows that many skins lightening cosmetics did not mention hydroquinone and mercury on their ingredients list but were found to contain high levels of these two[25]. Based on the evaluation of 20 Skin lightening cream found in cosmetics shops in Lagos, Nigeria even though these 20 cream have hydroquinone as their ingredient only 7 of the creams had hydroquinone in its label with four of them actually providing the value and among these 4 , three failed the USP specification.[26]

Arbutin

Arbutin is a hydroquinone glycoside that can be found in families like Ericaceae (bearberry, strawberry tree, huckleberry, and heather), Saxifragaceae, Asteraceae, Rosaceae, Lamiaceae, and Apiaceae. It is a skin lightening agent. Peracetylated-Arbutin can be prepared by Helferich glycosylat[ion reaction of penta-O-acetyl-β-D-glucopyranoside and 4-hydroxyphenylacetate, using the catalyst (BF3·Et2O)[27]. The chemical structure of arbutin consist of onemolecule D-glucose bound to hydroquinone. D-glucose exists in alpha, beta, or gamma anomeric form in aqueous solution, with beta-anomer being a dominant form. Beta-arbutin (this stereoisomer is called arbutin) in

which the beta-anomer of D-glucose is bound to hydroquinone and is mainly found in plants, such as wheat, pear, and bearberry. [28] Arbutin inhibits tyrosinase, preventing the conversion of tyrosine to L-dopa, and thus melanin formation is interrupted [27]. There are two isoforms of arbutin namely α-arbutin (4-hydroxyphenyl-α-D-glucopyranoside) which is biosynthesized by microbial enzymes or microorganisms and β-arbutin (4-hydroxyphenyl-β-D-glucopyranoside) which is extracted from leaves of various plants and fruit peels. Both have same chemical formula but different rotation configurations. α-arbutin is more efficient in inhibiting tyrosinase activity than natural arbutin. The 50% inhibitory concentration (IC_{50}) of α-arbutin in human tyrosinase is 2.0 mM, whereas, for natural arbutin, it is higher than 30 Mm. Researches shows that α-arbutin shows no cytotoxicity while inhibiting melanin biosynthesis in culture of melanoma cell and the human skin model. α-arbutin shows greater inhibition to tyrosinase enzyme than β-arbutin as the inhibition was found to be 10 times stronger than β-arbutin on a culture of mouse melanoma. α-arbutin did not inhibit the growth of cultured human melanoma cells, HMV-II, but inhibited melanin synthesis, it leaded to the conclusion that α-arbutin can be effective and safe for treating hyper pigmentation disorders. α-arbutin works similar to hydroquinone, but with less irritation and melanocytotoxicity.

It also does not cause exogenous ochronosis and is less likely to cause irritation and sensitization. α-arbutin can be synthesized by 2 ways, one is from hydroquinone using microbes and other is by enzymatic biosynthesis. Enzymatic biosynthesis is done by using an enzyme that catalyses alpha-anomer selective transglycosylation reaction between a glucosyl donor and hydroquinone as an acceptor. Tyrosinase help in the conversion of tyrosine to L-DOPA (monophenolase activity). It also catalyse the oxidation of L-DOPA (o-diphenols) thus leading to the formation of o-quinones (diphenolase activity). α-arbutin inactivate the active site of tyrosinase as well as lags the oxidation of tyrosine during the monophenolase reaction. As concentration of α-arbutin increased the lag time shows a dose dependant increase. During the diphenolase reaction, α-arbutin interacted with the residues located at the entrance to the active site, thus it acts as an activator and no lag period was observed during the oxidation of L-Dopa. Therefore α-arbutin exhibits dual effects on monophenolase and diphenolase activities of mushroom tyrosinase. α-Arbutin is a hydrophilic compound with lesser toxicity than hydroquinone. Since it is hydrophilic, it is very difficult for the alpha arbutin to penetrate the stratum corneum so various novel delivery systems such as micro needles, nano systems etc. can serve as a promising platform for the effective delivery of α-arbutin. Researches shows that Arbutin niosomes or arbusomes has skin lightening property without any irritancy and cytotoxicity. Combination of α-arbutin, kojic acid, vitamin C, or niacinamide have been reported to show synergetic effects. Such combinations increase the skin lightening effect. A combination of 2% α-arbutin and 3% trane xamic acid, 2% galactomyces ferment filtrate, and 4% niacinamide enhance skin lightening with no significant side effects.[29] In Maeda et al. it was reported that arbutin was more potent cellular melanin synthesis inhibiter than kojic acid when compared at a fixed concentration (0.5 mM). It doses dependently reduced TYR activity in human melanocytes at concentrations between0.1 and 1.0 mM without significantly decreasing cell viability [28].

Niacinamide
It is an active form of niacin (vitamin B3) is also an important precursor of NADH (nicotinamide adenine dinucleotide) and NADPH (nicotinamide adenine dinucleotide phosphate) found in yeast, vegetables etc. Niacinamide inhibits the transfer of melanosomes from melanocytes to keratinocytes thereby increase skin whitening property. It decreases collagen oxidation products and improve aging-induced yellowing or sallow ness. Niacin amide on topical application, penetrate the human skin and increase the level of NADH. It also a good choice for oily skin type because it reduces sebum production and pore size. Functions includes improved barrier function, decreased appearance of signs of photo aging, preventing the loss of moisture by enhancing production of ceramides and fatty acids [30]. Patricia K. Farris MD show that clinical benefits of niacinamide including reducing skin redness, improving sallow ness, and lightening. Niacinamide increases collagen and glycosaminogly can production, boosting dermal matrix components that can smooth wrinkles [31]. It has been used to treat skin conditions like acne and rosacea, a facial skin disorder characterized by redness and anti-inflammatory action. NA is very stable under exposure to UV radiation, heat, oxygen, acids, and bases Bora *Kim et al, show the cytotoxic effect by treated* B16F10 melanoma cells with NNT and result show that NNT have any cytotoxic effect in B16F10 cells in the

concentration range (10–500 μM) [32] for sensitive skin causes stinging, itching, mild burning etc. It dilates the blood vessels, which brings more Side effect blood to the surface of your skin. Niacinamide used in high doses cause redness of the skin. It's caused by the dilation of blood vessels, and it can cause a tingling sensation. when niacinamide mixed with the substances like vitamin C (ascorbic acid) or derivatives like tetra hydro curcuminoids, acid, folic acid, retinoids, benzoyl peroxide azelaic acid etc cause problems. it's safe to use up to a concentration of five percent niacinamide but higher doses cause side effect.

Mercury

Mercury is a heavy metal that exists in three forms: elemental, inorganic and organic[33]. Inorganic form of mercury mainly ammoniated mercury, mercury iodide, mercurous chloride, mercurous oxide, or mercuric chloride is used for cosmetic purpose as it has skin lightening property. Mercury compounds, including ethyl mercury, methyl mercury, and phenyl mercuric salts, may be used as preservatives in mascara and eye makeup cleansing products [34] Mercury inhibits melanin by inactivating sulfhydryl mercaptan enzymes this in turninactivates tyrosinase, an important catalyst in melanin production. Mercury ions replace tyrosinase enzyme anions, which inhibit the formation of melanin producing the whitening and anti-freckle effects. According to the Minamata Convention on Mercury the limit of mercury is 1ppm for skin lightening products but in order to increase the skin whitening efficiency many companies use mercury more than the limit which will lead to mercury poisoning effect. Since mercury can be absorbed through sweat glands and hair follicles it can cause many adverse effects such as damage to the skin, kidneys, and nervous system[33]. The pathway of mercury poisoning is that mercury reaches the liver via skin and after metabolism it goes to the bile duct and the part of this is re-adsorbed the remaining mercury goes out from the kidney. In this way continuous use of mercury containing products willlead to toxicity or poisoning over the period of time. Adverse health effect includes kidney damage, skin rashes, skin dis colouration and scarring, reduction in the skin's resistance to bacterial and fungal infections, anxiety, depression, psychosis and peripheral neuropathy.

In 2019, a case report from California states that a woman was hospitalised with blurred vision, weak muscles, and motor and speech difficulties due to mercury poisoning from a skin whitening cream[35]. In 2017 and 2018 Zero Mercury Group conducted a study on 338 samples of skin lightening creams from 22 countries with mercury as active ingredient. Among them thirty-four creams were found to have high mercury levels. Studies shows that nephrotic syndrome was mainly a problem among African women who uses ammoniated mercuric chloride–containing skin lightening creams for periods ranging from one month to three years. Studies on 16 skin-lightening creams from the local market of Jamaica were investigated and Six skin lightening products were found with mercury concentrations above the FDA allowable limit of 1 ppm and varied between 878 and 36,000 ppm[36]. Miserable pain, and limb, head, abdomen, or lumbosacral pain with poor response for nonsteroidal anti-inflammatory drugs, anti-epileptic drugs, and serotonin- nore pine phrine reuptake inhibitors, renal damage with proteinuria was the main complaints of 16 female patients diagnosed with chronic mercury intoxication from skin lightening products which had immediate and dramatic whitening effects[37].

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RESEARCH ARTICLE

Advanced Object Detection Algorithm using Deep Learning and Neural Network Approaches

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ABSTRACT

Nowadays object detection and segmentation which follows the algorithms of Feature extractions has become one of the most popular are a sin the field of image processing. A small feature gap exists between satellites or camera captured images and natural images. Therefore, deep learning and neural network algorithms could be applied to recognize images. Also it can be able to detect and identify the images. A Novel approach which is improved from Mask R-CNN model is developed to enhance the detection effect in the high-resolution camera captured, natural and remote sensing images which contain the dense targets and complex background. Our model can perform object recognition and segmentation in parallel. We also tried to work with WFA-1400 based on the DOTA dataset, remote sensing images too.

INTRODUCTION

With the development of the deep learning and neural network technology, researchers can detect the images and they can obtain higher-resolution remote sensing images. It is very useful in broad application prospects in civil and

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military applications. Since there is large set of input images and dense targets, object detection and segmentation in high-resolution images have always been a puzzle. There are some disadvantages when using traditional object detection algorithms, such as weak generalization ability and poor rotation invariance. The rapid development of deep learning (DL)algorithms such as convolution neural network(CNN) provides a best solution to this problem. It has excellent effects in object detection, image generation, segmentation, and high resolution image reconstruction. Various classifications of CNN based object detection techniques implements good results. We test our proposed algorithm on the WFA-1400 input dataset.

Related Work

The R-CNN is a deep learning approach which is a two phase detection algorithm. That is in this methodology, it identifies a subset of regions with convolutional neural networks (R-CNN). According to this technique, it accepts the input image and identifies the object. It also extracts many region proposals. It executes on forward propagation algorithm. On each region proposal it tries to extract its features. In this way it is used to analyze and predict the features of an image. By identifying the detected image with bounding box, region-based Convolution Neural Networks are included in the family of Deep learning paradigms. They are used in various applications of computer vision and image processing. [1].R-CNN is used to sketch the boundaries of an image and it detects the image.

Traditional Methods

Customary Deep learning algorithms follows the four steps given below to identify the object: region abstraction; feature analysis and extraction; feature dispensation; and taxonomy of the regions and objects. To extract and analyze the features of the region, the sliding window algorithm is proposed. The various regions and phases are extracted from images of different sizes. Aspect ratios are calculated from the entire image. A few specific optimization algorithms can be suggested to extract the features of region. According to Liu et al, he proposed a feature extraction method combining sparse coding and radial gradient transform. He derives poor detection results in the case of aircraft rotation.[2].In this article, Feature or region extraction processing includes two basic and fundamental methods such as feature synthesis and feature dimension saving. In many of the object detection algorithms, principal component analysis, Fisher discriminant analysis, and linear discriminant analysis are commonly implemented to detect the region. The classification process is derived and implemented with the use of support vector machine, Ada Boost, and conditional random field methods but professional knowledge is required to predict the features of region. But scheming a suitable, efficient, and robust features for the region of an image is a tedious process [4][5].Parameter adjustment is also critical and notable value in these types of paradigms.

Deep Learning Methods

Deep learning optimization algorithms are introduced to eliminate the problems occurred when abstracting the strong features. High accuracy is the important factor in many of object detection methods based on deep learning and neural networks. The deep learning neural network mechanisms helps to relieve the laborious hand-crafted features. They also overcome the problems of data annotations. According to object detection and segmentation methodologies, networks can be partitioned into single- and two-stage models,[6]where the division is carried out based on the generation stage of the candidate region. Our Proposed system works on hands on experiences of the theories to detect the object and segment it's features. Instance segmentation work is done with the help of bounding box mechanisms and the background pixels are identified with the pixels which are present within the bounding box. The rest of the part is belonging to the foreground [7]According to semantic segmentation each and every pixel in the detected object region are classified into a single class and it is used to distinguish each individual object in the given picture. In our proposed model, each bounding box is calculated to segment an object from the scene and to classify it. The bounding-box regression is applied to whole picture to identify the background of the model and front end elements of the image.[8]In traditional CNN, to extract the features of an region of the image, the classification, bounding- box regression, mask branch algorithms are used.

Sometimes it is observed that extracting rich features are very difficult due to the small targets in remote sensing images. In many cases it may lead to an inaccurate judgment and prediction. If the network has deep architecture and construction, complex functions and procedures are required to implement it. Also there are different levels of abstraction and various methods of extraction is needed to learn all the features that are identified. The learning process starts from the edge that is a lower level to very complex features which are in deeper level. Increasing the number of hidden layers of the network, in various deep network may affect higher experiment requirements on the hardware conditions. Also it targets and impacts the phenomenon of gradient disappearance. Our proposed strategy avoids all such complex method of changing the network structure and eliminates it very accurately. A huge resource over headed to implement it. The improved CNN paradigm helps to self-calibrate the feature information to supplement the missing targets' edge information in the feature map. [9][10].

CNN Model

A convolutional neural network (CNN or ConvNet), which is one of the current deep learning emerging network. It is based on the concept of deep learning constructions. It uses various techniques and directly involves in learning data. CNN architecture is evolved to find patterns in images. It also recognizes objects, classes, and categories. They can also use widely to classify and process audio, time-series, and signal image data. Convolutional Neural Networks are particularly used in image processing to recognize and analyze the patterns of the images. because they use various algorithms to extract features from images and learn to recognize patterns. It also well-suited for tasks such as object detection, image segmentation, and classification of various image sets.

R-CNN Model

R-CNN, a variation of convolutional neural network stands for Region-based Convolutional Neural Network. It mainly focuses on region proposals. Region proposals are the concepts that are used to localize objects within an image. In typical CNN, the class of the objects are identified. According to this environment, it is possible to regress bounding boxes directly. but it cannot able to locate it where it is. And it can also only happen for one object at a time. The R-CNN algorithm identifies where it is located and thus it can be easily identified. The Fast R-CNN methodology is faster than the R-CNN which shares computations across multiple proposals. The advantage of using R-CNN is that it samples a single ROI from each image. But Fast R-CNN samples multiple ROIs from the same image. For example, R-CNN selects and classifies a batch of 128 regions from 128 different images. The disadvantage of this method is that data requirements. They are the main challenges of Faster R-CNN and Mask R-CNN when it applied to real-world scenarios. These models of algorithms require huge amounts of annotated data to train the network and fine-tune it's regions. But it is a costly process. Also it is time-consuming methodology. Also these algorithms are very prone to errors.

Proposed Model

In a standard CNN model, the 3X 3-sized convolution kernel is used. It is implemented to integrate feature information [3]. But the kernel size of SC-con varies from the convolution 3 X 3 kernel size. Before convolution, the feature map A with a HXC X W shape must be evenly cropped into two branches according to the number of channels. We refer to them as A1 and A2, respectively, with the C/2 shape. The SC-conv structure can flexibly control the manner of feature extraction in space by cropping the feature map and setting the convolution kernel size. The A2 branch like the 3 X 3-sized convolution kernel with the same resolution as the input is used to extract the original spatial context information, called B2. B1 is obtained after self-calibration through the A1 branch. At the end of the SC-conv structure, B1 and B2 are concatenated together to obtain a feature map with more discriminative feature information.[11][12]. The 3X 3 kernel size can obtain only limited spatial information due to the limitation of the convolution kernel size, thereby ignoring the information in the larger field of view. This information loss will not have a significant effect in the recognition of natural images, but it appears to be very important in the recognition of small targets in remote sensing images. A small aircraft target may only occupy 32 X 32 px in a remote sensing image, which measures approximately 4000 X 4000 px. Thus, a large loss of learnable features will be observed for networks. We assigned more channels of feature maps to the A1 branch to weaken this problem.

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Increasing the number of channels in A1 will extract richer semantic information to supplement the missing target edge information in B1, enhance the target features in B1, and obtain a more discriminative feature map between the foreground and the background. For (P2, P3, P4, P5) , the network will gradually lose low-level feature information (e.g., outline and texture) as the number of layers increases, which is critical for semantic segmentation. Therefore, the self-calibration intensity must be increased to accurately locate the aircraft targets without losing basic spatial context information. We denote the channel ratio between A1 and A as ϕ, $\phi = 0.8$, corresponding to (P2, P3, P4, P5) . or the A1 branch, we first go through an average pooling operation with a size of r X r and a stride of r to obtain the spatial information F1 of a larger field of view, as shown in (1):

$$F1 = Avg Pooling_r (A1)$$

Second, F1 passes through K2 convolution and up-sampling in sequence then performs element-wise summation with A1 before passing through the sigmoid function. This output performs element-wise multiplication with F2 obtained by K3 convolution with A1, as shown in (2):

$$B' = (A1 * K3) \bullet \sigma(A1 + Up(F1 * K2)) \qquad (2)$$

where,* and σ represent convolution and sigmoid function, respectively. Third, B1 is
obtained by convolution K4, as shown in (3):

$$B1 = B' * K4 \qquad (3)$$

We use the improved SC-conv to extend the 3 X 3 kernel size to two spatial scales: the first is the A2 branch with the same resolution as the input X just like a 3X 3 kernel size; the second is the small size F1 after average pooling. In the A1 branch, self-calibration does not pay attention to global information because it inevitably contains information with a negative impact on the current spatial position. On the contrary, the self-calibration focuses on the information around the current spatial position through adjustable scale average pooling. It can obtain a larger field of view to effectively capture the informative context information, fill in the missing low-level feature information, and enhance high-level semantic information for each spatial position. Furthermore, each spatial position can reflect the dependence between channels in a greater extent, as shown in Equation (2). The improved SC-conv specifically increases the self-calibration convolution intensity in high-level feature maps to strengthen the connection between contexts. In this way, each spatial location contains more informative information and enhances the acquisition of low-level feature information (e.g., clearer texture) in the feature maps.

RESULT AND ANALYSIS

We used ResNet101 as the backbone network to extract features and the standard metrics to evaluate our results, including AP (average precision), AP50, and m IoU (mean intersection over union), and ensure the result validity. They are widely used to judge a deep network model's performance in object detection and instance segmentation. AP50 is the IoU threshold set from 0.52 to 0.97 with a step of 0.05. Table 2 presents the experiment results. The value of ϕ is set from 0.5 to 0.9 with a step increment of 0.1. We derived the comparison model with $\phi = 0.8$ as R-CNN+05SC. The outcome value increases, when the value of ϕ increases between 0.5–0.9.Slight advancement is recognised when SC R-CNN is compared with R-CNN+07SC. The outputs of SC R-CNN and R-CNN+09SC is observed almost the same when $\phi = 0.9$.

Loss and Training Time

Training our own model took an average of 3800 s and 3–4 s of each epoch and iteration, respectively. [13][14].When training the original R-CNN model, training the model of each epoch took 3600s. The time consumed for every iteration was almost the same as that of the proposed model. The training time comparison between SC R-CNN and Our proposed model illustrated that we controlled the increased time of training the model within an acceptable range and obtained better detection results than the original model. Our model reached a trade-off between time consumption and accuracy. Our proposed model is a multi-task model. The loss value is composed of the classification loss, bounding-box loss from the RPN structure, classification loss, bounding-box loss, and mask loss from the backend of the model. The experiment showed no satisfactory classification performance for many objects when it is detected using R-CNN, Fast R-CNN, and SC R-CNN. The classification performance is strongly related to the each and every object structure.[15][16].

CONCLUSIONS

This advanced proposed methodology is used to detect and segment the objects in various images. The WFA-1400 datasets are also incorporated to test modified SC-Faster RCNN.   Our model successfully obtained an improvement of about 2% in the accuracy compared to the basic network. Our study has practical significance for the research on various objects in the image dataset. In this work, we have proposed a model to distinguish the weapons by handling the on-going video and advising the client by means of an email and this can be utilized with caution-based frameworks in utilization of observation.[17][20]. We exploited one of the most up to date models, for example. The most encouraging outcomes are acquired from the YOLO-v5 model prepared on the 3000-gun picture data-set with the option of 12,000 negative class pictures. The prominent outcomes accomplished 93% accuracy with the speed per outline with 0.01s which is quicker than the Faster R-CNN model utilized by any other examination. [18].In future, we will pivot upon this model by utilizing other pre-processing methods like splendor control, we additionally found few regions where the presentation of the model is frequently expanded by taking care of the issues such as weapons which fluctuation [19]. Some other events such as cartheft detection, unauthorized presence in restricted area can be implement edin future

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Table 1. Object size distribution on WFA-1400

Size/Px	0–32	32–64	64–128	128–256	>256
Training Data	1210	2045	1827	533	45
Validation Data	135	142	248	132	15
Testing Data	138	315	145	92	19
WFA-1400	1488	2495	2226	766	71

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Table 2. Object Detection and segmentation process of various methodologies.

Method	AvgP/%	AvgP50/%	Mean IoU/%	Iteration Training Time/h
R-CNN	50.2	94.4	72.3	50.2
FAST R-CNN	49.9	95.6	71.7	52.5
FASTEST R-CNN	50.5	95.9	72.1	52.8
R-CNN+07SC	51.2	96.5	72.7	53
SC R-CNN	51.7	96.8	72.8	53.3
R-CNN+09SC	51.4	96.8	72.7	54

RESEARCH ARTICLE

Adsorption of Textile Dyes from Industrial Real Effluent using Marine Macro Algal Biomass *Sargassum natans*

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ABSTRACT

Large amounts of wastewater are produced by the growing world population, which also results in high energy demand. The present study aims to investigate the potential of macro algal biomass for the textile effluent treatment. The macroalgae taken for the present investigation is Sargassum natans. The effects of various process parameters, namelysorbent dosage, pH and temperature on adsorption were optimized using batch mode operation under the optimized condition. The biosorbent- adsorbate interactions were characterised using UV-Visible Spectrophotometer, FTIR (Fourier Transform Infrared Analyser) and SEM (Scanning Electron Microscope). Optimum conditions for dye removal Percentage (75.65%) from real effluent were obtained as sorbent dosage of 3 g/L, at pH 7 with contact time of 96 h and temperature at 45℃ with effluent concentration of 50% (mL). Based on the estimated characteristics, it is revealed that the real effluent is not suitable for direct discharge into water stream and need a suitable technology for the treatment before discharge. The results obtained in this work indicated that the potential use of macro algal biomass as a bio sorbent is feasible in the treatment of real textile effluent.

Keywords: Biosorption, Macroalgae, Textile dye, Real Effluent, Sargassum natans,

INTRODUCTION

Water pollution is one of the environment problems which causes severe impact to living organisms. South India is well known for textile industry. Coimbatore, Tirupur, Salem and Erode, these four districts are known as textile belt of South India and based on literature survey, the export revenue generates more than 25,000 crores. This industry was the main contributor of wastewater effluent due to high consumption of water during dyeing, washing and finishing processes. Industries release waste water contaminated with heavy metals, chemicals, dyes, oils and many other hazardous substances directly released into water bodies without any treatment [1].All of the dye wastes, which are generated by many types of enterprises, could have negative effects on the microbial population and be dangerous or even lethal to animals. These colours have been linked to cancer, skin rashes, mutations, and allergic eczema etc. Few chemicals that are utilized to make dye are extremely poisonous, cancer-causing and hormonally disruptive. In addition to prevent sunlight from penetrating water and reducing photosynthetic activity, this also affects the atmosphere, creating problems. The life cycle of aquatic creatures and plants is hampered by dye released into water bodies because it blocks sunlight from penetration [2]. They contribute to the scarcity of dissolved oxygen by simultaneously increasing the biological oxygen demand (BOD) needed to support aquatic life. Some dyes inflict direct harm to cells or hinder their ability to respond chemically because they are extremely cyanogenic. As intended, dyes loaded in effluent are extremely stable compounds built to fend against deterioration by light, biological, chemical and other factors [3].Thus, it is necessary to develop an effective and efficient method to remove the toxicants from wastewater before being discharged into natural water stream. With the search of a new dimension of treatment methods; adsorption treatment for the control of water pollution is less investment in terms of initial development cost, simple design, easy operation, no generation of toxic substance sand safe recovery of the adsorbent. Macroalgal biomass which is popularly known as seaweed biomass will be used as the adsorbent in the treatment of textile effluent.

It was chosen as it is a ubiquitous biological resource and is most predominant that contains alginate gel in their cell walls which offers a convenient basis for the production of bio sorbent particles that are suitable for sorption processes and also the presence of abundant dye uptake functional groups [4]. The growing human population has posed numerous challenges to the global economy particularly in terms of environmental conservation. Textile wastewater treatment appears to be the biggest challenge to textile sectors. The application plays an imperative role in bio monitoring; accordingly, this project study targets to overview simultaneous bioremediation of textile effluent and the macroalgal biomass with textile dye molecules, which can be useful in biogas production. Previous research works were established only for the removal of synthetic synthetic textile effluent using algal-biomass [5]. Few research works were established on real industrial effluent using algal biomass. Keeping in view the significance of textile effluent and their environmental problems, the current study was undertaken to explore the bio sorption potential of two macro algal biomass for the removal of dye molecules from effluent and the feasibility of treated macro algal biomass with dye molecules in the production of biogas.

MATERIALS AND METHODS

Effluent and reagent
The effluent was collected from a small-scale dyeing unit at Sirumugai, Coimbatore district, Tamil Nadu. Coimbatore is famous worldwide for its handloom textile products. The sample was collected in pre-cleaned 20L polythene bottles from the point of discharge of the industry and preserved in a refrigerator at 4º C till the completion of the investigation. All other chemicals used in the present study were of analytical grade. De ionised water was used for all dilutions.

Collection and identification of algal sample

Seaweed (Figure 1) was collected from Mandapam, a small panchayat town in Rameswaram district, Tamil Nadu, India (98.28°N 79.12°E). The live and healthy macro algal sample was collected by handpicking method at a depth of 1-2 m. Algal species was identified and taxonomic classification of the algal species was made. The identification was based on (a) morphological, using external and internal characteristics and (b) ecological distribution and habitat.

Preparation of adsorbent

The collected seaweed (Sargassum natans) was washed several times to remove dust and was shade dried until all the moisture evaporated. It was cut into small pieces and ground to a fine powder in an electric grinder. The powder was sieved through a mesh to get fine particles of size 150μm. The material was stored in an airtight container for further use.

Batch adsorption studies

The batch adsorption experiments were conducted to optimize the various operational parameters namely adsorbent dose, initial pH, temperature and contact time to obtain optimum colour removal from the effluent. Batch studies were conducted with fixed amounts (1 to 5 g/L) of adsorbents which were shaken separately in a rotary orbital shaker at 150rpm in 100ml of the diluted effluent of 50% concentration at different temperatures (25,35,45, 55 and 65ºC) and pH (3-10) for definite time periods (96 h). At the end of the predetermined time intervals, samples were withdrawn from the shaker and the adsorbents were separated from the solution in a centrifuge at 12,000 rpm for a period of 5 minutes. The absorbance of the supernatant solution was read by UV-Visible Spectrophotometer at 340nm to estimate the final effluent concentration. All experiments were carried out thrice with respect to each condition.

Colour removal efficiency was computed with the following formula

$$(\%) \text{ Color removal} = \frac{\text{Initial concentration} - \text{Final concentration}}{\text{Initial concentration}} \times 100$$

Physicochemical characterization of raw and treated textile dyeing effluent

The raw and treated effluents were subjected to various physicochemical analyses according to the methods of APHA 2005 (American Public Health Association2005).

Analytical studies

The dye solution before and after adsorption was characterized for neutralization of pH and further the biomass was characterized by FT-IR (Perkin Elmer PE 1600)for analysing functional groups.Adsorbate concentration was analysed by UV-Visible spectrophotometer (Schimadzu UV-1800). The surface morphology of the sorbent was documented by SEM (Model JSM-6100).

RESULTS AND DISCUSSION

Adsorption optimization studies
Effect of adsorbent dosage

The effect of adsorbent dosage (1- 6 g/L) for the removal of dye in effluent using S. natansis shown Figure2. The maximum removal was observed as 48.34% at 3.0g/L. When the adsorbent dose was further increased from 3.0g/L to 5.0g/L there was a decrease in the bio sorption capacity of adsorbent. At the adsorption dose of 5.0g/L the percentage removal was 36.64% for S. natans. Adsorption efficiency decreased with increase in the bio sorbent dose. The percentage removal of dye increases with increase in the adsorbent dosage up to a point but after that there is no significant increase in the removal. This can be explained by the fact that on increasing adsorbent dosage, the surface area of the adsorption sites increases. But there is no significant increase in adsorption capacity further even after adding more adsorbent which might be due to the interactions between particles within themselves[6].

From the results, it can be observed that the removal efficiency of the dye generally improved with increasing algal biomass and reached equilibrium at 3.0 g of biomass. Ruangsomboonetal., (2013) reported that the removal of textile effluent using macroalgae decreased from 8.60 to 0.77 mg/g when the Padina sp. biomass was increased from 0.5 to 6 g/L [7]. Naveenet al. (2011) reported that the amount of dye adsorbed varied with initial adsorbent (Hydrilla verticillata) dosage [8]. Although it is simple to understand, the biosorption process is significantly impacted by the dose of the bio sorbent. Bio sorbent dose plays a very important role in the process of biosorption. The dye bio sorption capacity decreased at higher bio sorbent doses due to the aggregation of the biomass which results in a decrease in active sites on the surface of the bio sorbent available for the attachment of dye molecules[9]. Another important factor is that at high bio sorbent doses, the available dye molecules are insufficient to completely cover the available binding sites on the bio sorbent, which usually results in low solute uptake [10]. Thus, the most efficient operational parameters in the current study were maintained as pH of 8, temperature of 35ºC and contact time of 98 hfor the treatment of textile effluent of 50% dilution using Sargassum natansas an adsorbent. The removal of pollutants is dependent on the dye concentration, biomass concentration, pH and temperature.

Effect of pH

The effect of pH on textile dye adsorption on Sargassum natansis shown in Figure3. The effect of pH was studied by varying the pH from 3.00 to 9.00. At pH 3.0, the minimum adsorption of 25.00% using S. natans was recorded. With further increase in pH, a gradual increase in percentage colour removal was observed with 35.00% using S. natans at pH 4.00 and 45% using S. natans at pH 5.00, which recorded a maximum of 55 % using S. natans at pH 6.00. pH 7.00 recorded a slight increase in adsorption (65% using S. natans). Above pH 7, the adsorption percentage was gradually decreased and recorded at 52% using S. natans at pH 10.00. The present study clarified that the removal of textile effluent by using algal biomass is affected by pH. The textile dye removal was increased to some extent by increasing the pH. Maximum dye removal was observed at pH 7.0. On the other hand, high pH values deprotonate hydroxyl, amine, and carboxyl functional groups which promotes the formation of hydroxide anionic complexes that tends to precipitate and impeding effective adsorption [11]. Thus, the pH value of the solution is an important process parameter controlling the adsorption of dye. The initial pH values of the dye solutions affect the surface charge of the adsorbent and thus the adsorption of charged dye groups on it. At an acidic pH condition, the hydroxyl and carboxyl groups on the surface of macroalgae are protonated, and they inhibit the binding of the dye cation and promote the binding of the dye anion [12]. In the present study, neutral conditions (pH 7) favour dye adsorption from the textile effluent.

Effect of temperature

The effect of temperatures was studied in the range from 25°C to 45°C (Figure 4). The percentage of dye removal was increased for the rise in temperature from 25°C to 45°C (48.15 - 75.65 for S. natans). Further increase in temperature from 45°C to 65°C (75.65 – 59.68 for S. natans) could not increase removal percentage, rather a decrease was observed. Therefore, the maximum removal of dye from effluent was achieved at 45°C which is recorded as the 75.65% using S. natans. This was achieved because as temperature increases from 25°C to 45°C, a slight increase in the surface area of the adsorbent could be possible but a further increase in temperature above 45°Cresults in the loss of active surface area resulting reduction in the colour removal percentage. Hence, the adsorption was slow at high temperatures. The optimum temperature was 45°C at which the adsorption was very effective and the present study shows the exothermic nature of adsorption. The results of the present investigation are in accordance with Renganathan et al., (2008) who observed that the optimum temperature was 30°C at which the adsorption was very effective[13].Renganathanet al., (2008) also reported the highest efficiency of dye removal at 30ºC with a decrease in bio sorption below 30ºC [14].

The decrease in viscosity of the solution caused by an increase in temperature can improve the diffusion of adsorbates over the bio sorbent's superficial layer and inner pores. It can also increase the number of active sites available for adsorption and improve the stability of the connections between dyes and the functional groups of the biomass [14].

Analytical studies (characterization of adsorbent and dye solution)
SEM (Scanning Electron Microscopy)
The surface features and morphological characteristics of the bio sorbent was studied using SEM (Scanning Electron Microscopy) analysis. The study was useful in determining the particle shape and porous structure of the adsorbent for S. natans. SEM micrographs of the algal biomass and textile dye-loaded biomass are presented in Figure 5. From the micrographs, it was evident that before adsorption, the structured arrangement of the seaweed showed that the interconnected tube cells is visible and the cell wall of the intercellular matrix remains almost intact. The pores within the seaweed particles are assorted, the surface was rough and irregular in shape which might be indicated that there is an adequate space for dye adsorption [15]. Whereas after adsorption, a significant change was observed in surface of the adsorbent, which clearly indicated the porous and fibrous texture of the bio sorbent with homogeneity that could contribute to the bio sorption of the dye. The morphological changes of the seaweeds surface after dye adsorption may be attributed to the differences in pores, morphology, and structure of the cell walls of algae [16]. The cell wall of S. natans before adsorption was very porous and easily permeable to ions. This may explain the highest affinity of S. natans biomass for the removal of pollutants from the effluent.

FT-IR Analysis (Fourier Transform Infrared Spectroscopy)
FT-IR spectra of seaweeds particles before and after the adsorption of textile effluent were analyzed to determine the vibration frequency changes in their functional groups within the range of 4000 to 600 cm^{-1}. The FTIR spectrum aids in the identification of the molecular components and their structures. In this study, FT-IR spectrum is able to predict the main chemical constituents in S. natans before and after adsorption of the textile dyes from effluent [17]. The absorbance at 3294.42, 1635.63, 1527.62, 686.65, 601.79, 555.49, 493.77, 447.48 and 416.62cm^{-1} are seen in the spectrum of biomass before adsorption (Figure 6). The major peaks are at 3294.42, 1635.63 and 1527.62cm^{-1}. The peak at 3294.42 cm^{-1} indicates the presence of free and intermolecular bonded hydroxyl (-OH) of cellulose, hemicelluloses, and pectin. The peak at 1635.63 cm^{-1} reveals the existence of C=O from esters probably of lignin and hemicelluloses [18]. On the other hand, the absorbance at 3741.90, 3263.55, 1643.35, 686.65, 601.79, 555.49, 486.06, 462.915 and 416.62 cm^{-1} are seen in the spectrum of biomass particles after adsorption using *Sargassum natans* (Figure7). The major peaks are at 3741.90, 3263.55, and 1643.35 cm^{-1} which includes hydroxyl, amine, and an ester group. The remaining peaks include halogens or ether groups. IR spectra for textile effluent treated with S. natans were observed on the cell surfaces of 3741.90 cm^{-1} (OH, CONH, and NH), and 3263.55cm^{-1} (-OH). Several indicator bands that are pertained to functional groups represent chemical components or metabolic products [17].

CONCLUSIONS

Real textile effluent treatment is difficult because it contains toxic compounds that have low biodegradability. Finally, more efforts are needed by water technologists and textile industrial experts to reduce water pollutants produced from industry and in the urge to decolourize before discharge to the environment. In the present study, Sargassum natansspecies acted as the adsorbent and was used successfully as a low-cost and effective adsorbing agent for the removal of dyes and pollutants from textile effluent, which could be used for textile wastewater treatment at an industrial scale. From the study, it could be concluded that the studied textile effluent has high pollution potential and warrants an urgent need to follow adequate effluent treatment methods before discharged into surface water for reducing potential environmental hazards. It is also evident that the macroalgae (S. natans) as an adsorbent may provide a promising approach towards textile wastewater treatment.

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Figure 1. Seaweed (Sargassum natans)
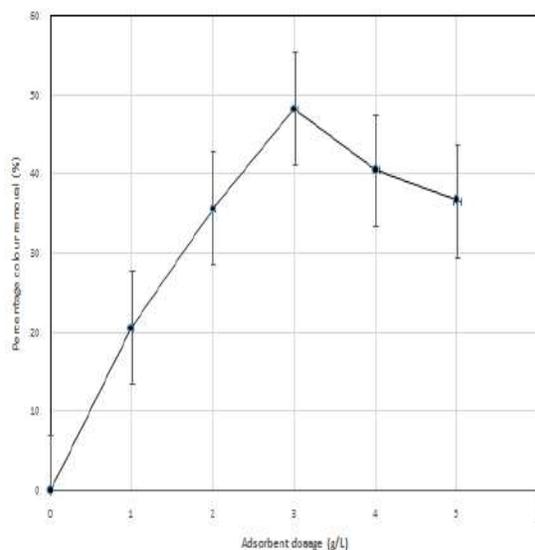
Figure 2. Effect of adsorbent do sageon adsorption of dyes from real effluent using *Sargassum natans* (Initial dye concentration: 50(%), Agitation: 150 rpm, Temperature: 35 ºC, pH: 8 and Contact time:96 h).
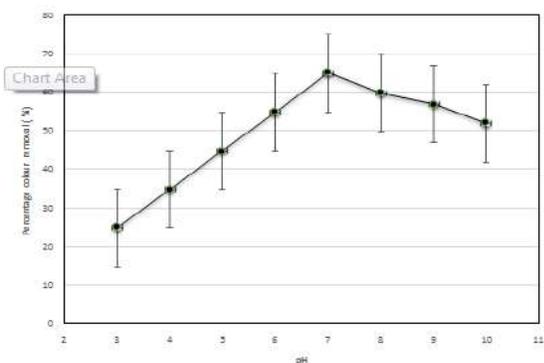
Figure 3. Effect of pH on adsorption of dyesfrom real effluent using *Sargassum natans* (Initial dye concentration: 50(%), Agitation: 150 rpm, Temperature: 35 ºC, Sorbent dosage: 3 (g/L) and Contact time:96 h).
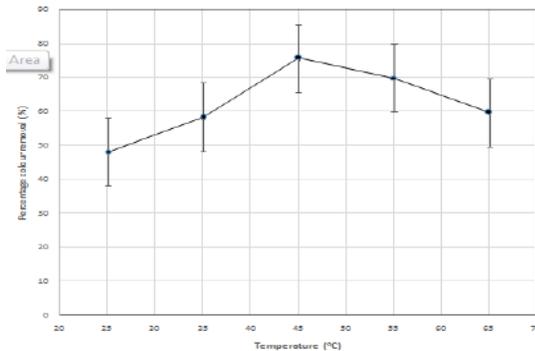
Figure 4. Effect of temperature on adsorption of dyes from real effluent using *Sargassum natans* (Initial dye concentration: 50(%), Agitation: 150 rpm, pH:7, Sorbent dosage: 3 (g/L) and Contact time:96 h).

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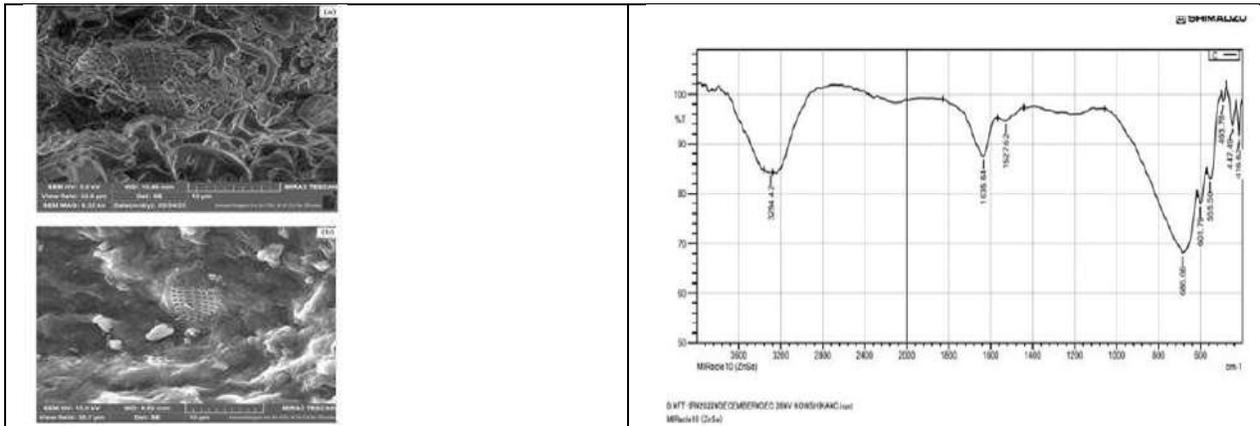
Figure 5. SEM image of *Sargassum natans* (a)before and (b)after adsorption of dyes from real effluent.

Figure 6. FT-IR Spectrum of *Sargassum natans* before adsorption of dyes from textile real effluent.
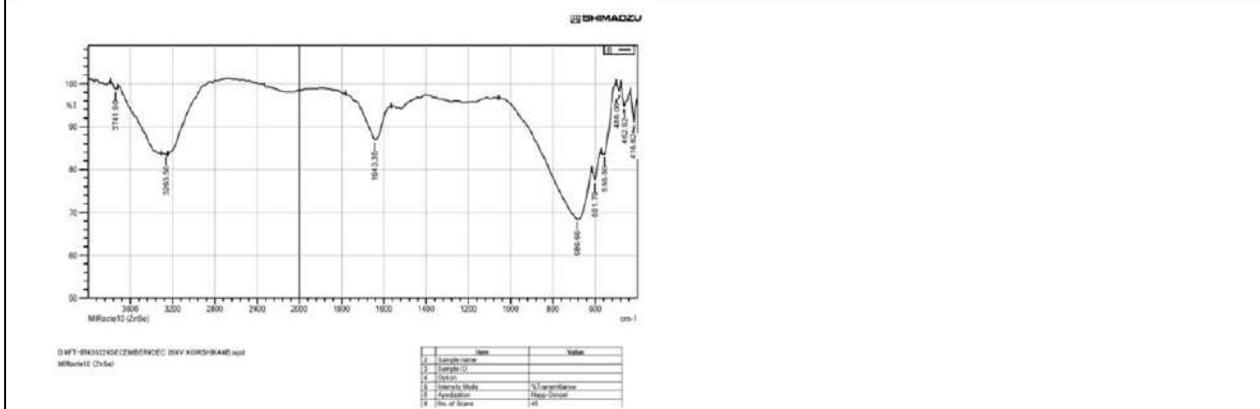
Figure 7. FT-IR Spectrum of *Sargassum natans* after adsorption of dyes from textile real effluent.

RESEARCH ARTICLE

Effect of Sprouting on Nutritional Composition and Morphological Characteristics of Milk Extracted from Moth Bean (*Vigna aconitifolia*)

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ABSTRACT

In recent years, the demand for vegetable milk has experienced a significant surge in consumption. This growing trend reflects a shifting preference towards plant-based alternatives as a nutritious and sustainable choice for individuals. The present study focused on the effect of processing on the nutritional and structural characteristics of milk extracted from sprouted and non-sprouted Moth Beans (*Vigna aconitifolia*).The milk was extracted from the sprouted and non-sprouted moth beans. The nutritional composition including moisture, ash, pH, carbohydrate, protein, fat, fiber, calories, and iron was analyzed. Additionally, the morphological structures of both sprouted and non-sprouted were studied. The results demonstrated that the sprouted milk exhibited higher protein content, moisture, and ash whereas carbohydrates and calories were lower compared to the non-sprouted milk. The morphological study revealed that both types of milk had oval and hexagonal shapes with a ruptured surface. Therefore, this study concluded thats prouted Moth bean milk may have the ability to reduce the anti-nutritional properties and enhance the bioavailability of amino acids and other nutraceutical elements.

Keywords: Moth bean, sprouted milk, SEM, Nutritional composition, EDAX

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INTRODUCTION

In India, milk production ranks as the topmost in the country, with a significant number of people depending on milk as a vital dietary component. However, despite the importance of milk, some individuals face complications in incorporating it into their regular diet due to lactose intolerance, hypercholesterolemia, hormone imbalances, and other factors. As a result, there is a growing demand for alternative options to fulfil their nutritional needs. Exploring and promoting these alternative sources can provide a valuable solution for individuals seeking dairy-free or modified dairy options that address their specific dietary concerns. Legume beverages, resembling cow's milk in appearance and consistency, are colloidal suspensions consisting of dissolved and disintegrated plant material in water [1].However, various technological challenges often arise in the processing and preservation of these plant-based beverages. Legume beverages offer a well-balanced composition, being rich in proteins and minerals, and boasting a low glycemic index. Their protein content, approximately 3-4%, is comparable to that of cow's milk, which typically falls within the range of 3.3-3.5%. In contrast, cereal and nut-based beverages typically exhibit protein values ranging from 0.1% to 1.0%. Among legume beverages, soy milk stands out as the most widely consumed, sharing similar protein content to that of milk, with a minimum of 3% [1].

Several pulse crops, such as pea, faba bean, lentil, lupin, chickpea, and common bean, show potential as alternative protein sources in the development of milk alternatives and related products. Pea protein-based milk substitutes with high protein content have already become commercially available for the vegan market [2]. However, compared to soybeans, most pulses contain higher levels of starch and other carbohydrates [3]. To achieve milk alternative formulations that approach the nutritional value of cow's milk, it is likely that protein isolation/concentration steps would be necessary for most pulses. Currently, the most widely accessible pulse protein concentrates or isolates are derived from peas [4]. Moth bean serves as a versatile crop, providing food, fodder, feed, and serving as a green manure and pasture. Its green pods are delicious and a valuable source of vegetables. As a pulse, moth bean offers an affordable vegetable protein option to address nutritional deficiencies, particularly in areas with less productive soils where many financially disadvantaged individuals rely on it for their livelihood. Moth bean is renowned for its high proportion of albumin and glutamine protein fractions and is also rich in lysine and leucine amino acids. Moreover, the dry seeds of moth beans are widely used in the preparation of various delectable confectionery items such as papad, mangori, mogar, and bhujia-namkins, which are commonly enjoyed as daily snacks. These industries have experienced significant growth, exporting these commercial edible products and creating employment opportunities in the agro-based sector [5].The bean is also rich in resistant starch, vitamins, and fructo-oligosaccharides. These components have been shown to provide protective effects against oxidative stress, heart disease, diabetes, cancer, and metabolic syndrome (MetS) [5].Therefore, considering the increasing demand and the potential it holds, the present study aimed to find the effect of sprouting on the nutritional and structural characteristics of milk extracted from sprouted and non-sprouted Moth beans.

METHODOLOGY

Sample Collection and Authentication
The moth beans were procured from the local market, in Salem, Tamil Nadu and it was authenticated by the Indian Botanical Survey (Tamil Nadu).

Extraction of Milk from Sprouted and Non-Sprouted Moth Bean
Sprouted Milk
To disperse the protein fraction and starch granules, facilitating protein denaturation and starch gelatinization, 100 grams of moth beans were soaked in water for 12 hours. This soaking process helps soften the texture of the legumes. After draining the water, the soaked moth beans were placed in a wet cloth and hung for an additional 48 hours to

allow sprouts to form. The sprouts were then ground with water using a 1:2 ratio and the milk was extracted using a muslin cloth and stored in an airtight container for later use.

Non-Sprouted Milk
Similar to the process mentioned in section 2.2.1., the soaked moth beans (100 grams) were ground with water (1:2 ratio) to form a mixture. The mixture was then strained using a muslin cloth to extract the milk and stored in an airtight container for later use.

Nutritional Composition
Proximate Composition and pH
The proximate analysis such as moisture, total ash, carbohydrate, calorific value, protein, fiber and fat of the sprouted and non-sprouted moth bean milk was analysed by the AOAC method. The pH was determined using the Electrometric method for both extracted milk.

Iron Estimation
The total Ironcontent of sprouted and non-sprouted moth bean milk was determined by the AOAC method and compared with each other.

Morphological Study (Scanning Electron Microscopic with EDAX)
The morphology study of sprouted and non-sprouted moth bean milk was analysed using a scanning electron microscope (SEM) (EVO 18: UK with SE, BSE, VPSE, and EDS detectors). For analysis, the samples were mounted on circular aluminum stubs using double-sided sticky tape. The milk was placed on the tape's surface. Subsequently, a 12 nm gold coating was applied to the samples. The samples were then examined and photographed at an accelerating voltage of 5 kV with a magnification ranging from 1x to 1,000,000x.The EDAX was performed using a Hitachi S-3000N microscope. The analysis demonstrates the presence and location of the elemental constituents of additives like calcium carbonate.

RESULTS AND DISCUSSION

Nutritional Composition
Proximate Composition and pH
The effect of sprouted moth bean millet on nutritional composition is shown in Table 2. The moisture content of sprouted milk significantly increased compared to non-sprouting moth bean milk. After water entry into the seed coat, seed swelling starts and initiates sprouting. During sprouting, the water intake of the seed varies. A similar trend was observed in recent studies [6 & 7] in in soybean (5.4 to 56.1 % after 48 h of sprouting) and cowpea (15.6 to 17.6 % after sprouting) respectively. Usually during sprouting, seeds absorb water by a process called imbibitions[8 & 9]. Ash is a non-organic compound continuing mineral contents in food and nutritionally aid in the metabolism of organic compounds such as fat and carbohydrate. The sprouted moth bean milk observed ash content was significantly lower compared to non-sprouted moth bean milk as reported by [10 & 11] in chickpea and mung bean respectively after germination.

Sprouted moth bean milk had 4.56 g/100 g of carbohydrates whereas non-sprouted was noticed to 6.40 g/100g. A significant reduction in carbohydrates was observed during sprouting, this could be due to enhanced hydrolytic enzyme activities that promoted starch digestibility[12]. A decrease in carbohydrates during germination made the sprouts popular in developed countries due to their low carbohydrates and rich in vitamins [13]. The calorific value also followed the same trend of reduction during sprouting it may be due to low levels of fat and carbohydrates as opted by [14]. Non-sprouted moth bean milk (35.80 kcal) was a significantly higher calorific value than the sprouted moth bean milk (28.76 kcal).

The report on sprouted soybean milk (7.47–9.54%), the protein level of both sprouted milks was between 2.55–2.63 g/100 g [15], while the fat content was less than 0.1 g/100 g in both cases. Protein and fat results revealed that moth

bean milk, whether sprouted or not, is an excellent source of protein due to its high biological value and when compared to seed. The processes which promote the biochemical mechanisms in the human body during germination include the breakdown of polysaccharides into oligo- and monosaccharides, free fatty acids, free amino acids, and oligopeptides. They therefore increase the effectiveness of the enzymes that break down carbohydrates, fatty acids, and proteins.

Iron Estimation

The total iron content of sprouted and non-sprouted Moth bean milk ranged between 1.09 mg/g and 1.66 mg/g. The results indicate that there are slightly significant variations noticed among the samples. However, when comparing the samples, it is noted that non-sprouted milk (1.66 mg/g) has higher iron content than sprouted milk (1.09 mg/g). Similarly, [16] reported that there were no significant variations in the iron content of soaked faba bean and mung bean, but azuki bean showed a significant ($P < 0.05$) reduction in iron content when soaked. Sprouting or controlled germination of legumes reduces anti-nutritional factors and improves their overall nutritional quality [17]. During germination, minerals like calcium, zinc, and iron are released from their bound form, and phytic acid is reduced, resulting in increased availability of minerals [18].

M. Sativa sprouts were found to have three times the iron content compared to dry seeds. On the other hand, during the sprouting process of soybeans, the iron concentration decreased, while no significant changes were observed in wheat grain. This observation was supported by [19], who demonstrated that the trend and level of mineral composition variation between untreated and sprouted soybean seeds depended on the plant's genotype. In the case of sprouted seeds of *Phaseolus vulgaris* and *Cajanus cajan*, [20] discovered that the content of calcium and zinc was higher, while the concentration of iron was lower compared to raw seeds. The study of [21 &22] observed a negligible increase in iron content in sprouted seeds of cowpea genotypes. The study of [23] also reported that soaking and different sprouting periods did not result in significant variation in the iron content of mung beans and cowpeas, while chickpeas experienced a reduction in iron content when soaked and germinated. The authors noted a significant decrease in calcium and zinc levels in soaked and germinated mung bean and cowpea seeds. Therefore, the difference in iron content between sprouted and non-sprouted moth bean milk may depend on the plant's genotype, and there is no mandatory requirement for a natural increase in iron content during sprouting based on previous evidence.

Scanning Electron Microscopic with EDAX Analysis

The morphological structure of sprouted and non-sprouted moth bean milk is depicted in Figures 1 and 2, respectively. Fig. 1 shows particles of sprouted milk with oval shapes, rough surfaces, and occasional smooth areas, which are typical features associated with sprouting. In contrast, Fig. 2 displays non-sprouted milk particles with very rough surfaces and a hexagonal shape. Both the sprouted and non-sprouted milk predominantly exhibit granules with pitted surfaces, which could be attributed to amylase activity. This finding is consistent with previous studies conducted by [24 & 25]. Additionally, porous surfaces were observed in the particles. The results of EDAX (Fig. 3, 4 and Table 3) revealed that the elements such as carbon (C), oxygen (O), Magnesium (Mg), Phosphorus (P) and Potassium (K) were noticed in both the sprouted and non-sprouted milk. The other elements such as Nitrogen (N), Sodium (Na), Aluminium (Al), and Chloride (Cl) were recorded by the Sprouted Milk alone. The elements present are expressed in weight percentage and in proportion to the total elements of the area analysed.

CONCLUSION

The present study highlights the potential of moth bean as a versatile and nutritious crop for the development of milk alternatives. The nutritional analysis revealed that both sprouted and non-sprouted moth bean milk offer a balanced composition, with protein content comparable to cow's milk, making them suitable protein sources for individuals with dietary restrictions. Additionally, sprouting was found to have positive effects on the nutritional profile of moth bean milk, leading to reduced carbohydrates and increased protein content. Moreover, the presence

of iron in both sprouted and non-sprouted moth bean milk indicates its potential as a valuable source of this essential mineral. Although the iron content was slightly higher in non-sprouted milk, further investigation into the genotypic differences might shed more light on this aspect. The morphological analysis using scanning electron microscopy demonstrated the characteristic granular appearance of both sprouted and non-sprouted moth bean milk, with indications of amylase activity, which contributes to the digestibility of starch during germination. Moreover, promoting and utilizing legume-based milk alternatives can have a positive impact on sustainable agriculture and the agro-based industry.

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Table 1: Nutritional Composition of Sprouted and Non-Sprouted Moth Bean Milk

S.No.	Name of the Sample	Unit	Sprouted Milk	Non-Sprouted Milk
1.	Moisture	%	92.55	90.76
2.	Total Ash	g/100g	0.26	0.29
3.	Carbohydrate	g/100g	4.56	6.40
4.	Calorific value	kcal	28.76	35.80
5.	Protein	g/100g	2.63	2.55
6.	Fiber	g/100g	0.1	0.1
7.	Fat	g/100g	0.1	0.1
8.	pH	-	4.70	4.37

Table 2: EDAX Pattern of Sprouted and Non-Sprouted Moth Bean Milk

S.No.	Name of the Sample	Element	Weight (%)	Atomic Weight (%)
1.	Non-Sprouted Moth bean milk	CK	52.11	59.78
		OK	45.36	39.06
		MgK	0.85	0.48
		PK	0.92	0.41
		KK	0.77	0.27
2.	Sprouted Moth bean milk	CK	39.25	46.46
		NK	10.02	10.17
		OK	46.32	41.16
		NaK	1.35	0.83
		MgK	0.64	0.38
		AlK	0.29	0.15
		PK	0.77	0.35
		ClK	0.19	0.08
		KK	1.17	0.43

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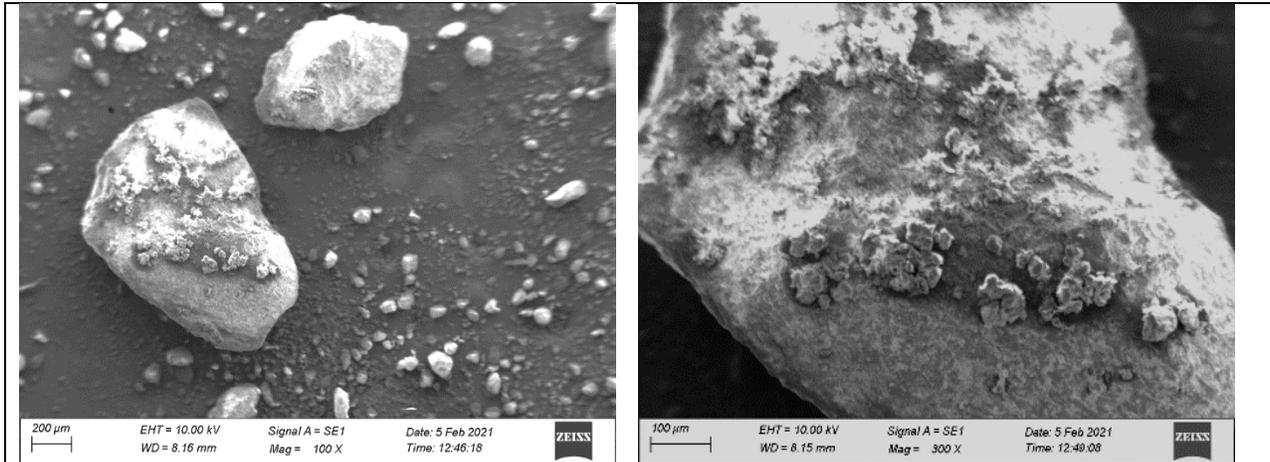
Figure 1 SEM image of Non-Sprouted Moth Bean Milk
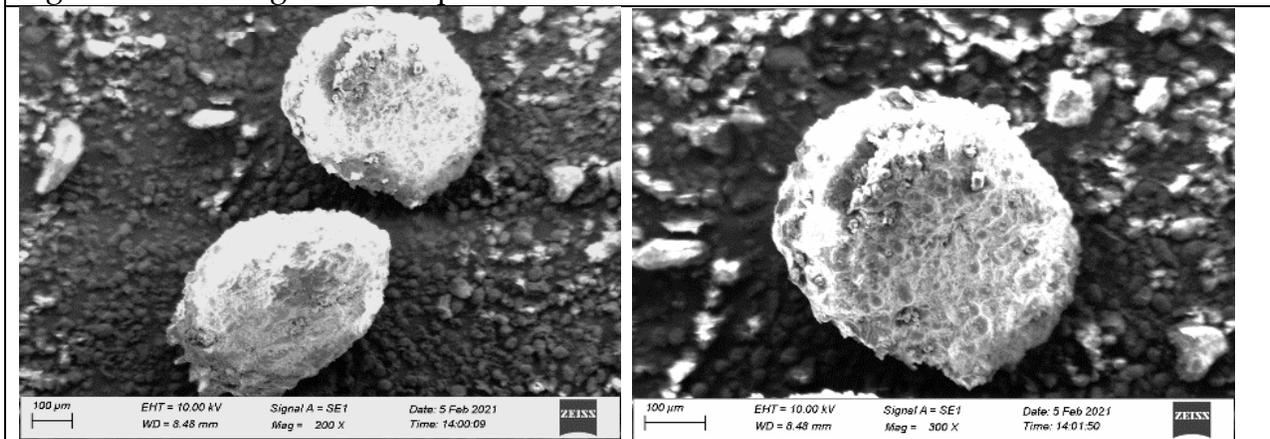
Figure 2 SEM image of Sprouted Moth Bean Milk
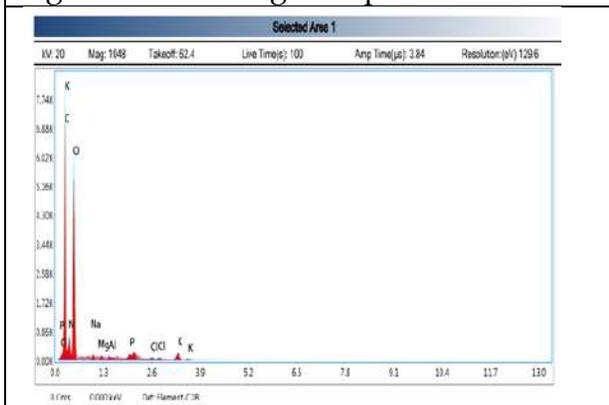
| Figure 3. SEM EDAX Pattern of Sprouted Moth Bean Milk | Figure 4. SEM EDAX Pattern of Non-Sprouted Moth Bean Milk |
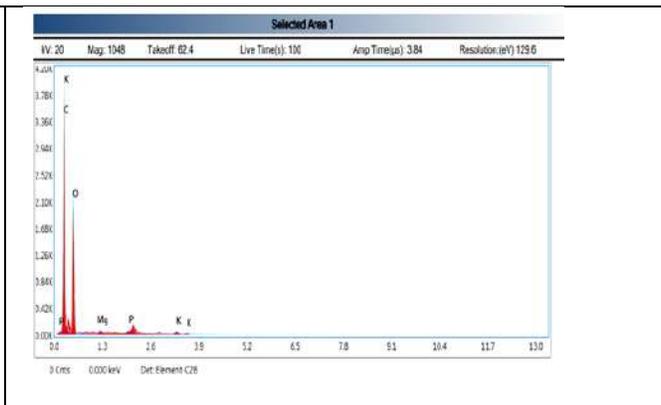
RESEARCH ARTICLE

Teachers' Attitude towards Teaching Mathematics in Digital and Traditional Classroom for Secondary Level Students

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ABSTRACT

Teachers' positive attitude towards teaching is one of the significant factors of pedagogical enrichment. In today's high-tech world teachers' attitude towards use of technology during classroom sessions is a matter of concern. This study focuses to differentiate teachers' attitude towards teaching mathematics with and without using technology during teaching. Adopting descriptive survey method Kolmogorov-Smirnov Normality test for normal distribution; Mann Whitney Test for testing the significance of difference between the teachers' attitude towards teaching mathematics in digital and traditional classroom; Tukey Post Hoc test for finding out the paired mean difference and level of significance are run. Under both of the government and private sectors, teachers' attitude towards teaching mathematics does not matter whether it is digital or traditional approach within the domain of study.

Keywords: Teachers' attitude, teaching and learning, pedagogy, ICT

INTRODUCTION

According to the National Policy of Education (1968), the most essential component determining the quality of education and its contribution to national development is the teachers. Teachers are more than just teachers; they are also organizers, controllers, and motivators."A new teacher is put at the epi centre of educational transformation," according to the International Commission for the Development of Education [1].The teacher of the new millennium has to be able to in still in his or her students' fundamental competencies and attitudes such as creativity, receptivity

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to change and innovation, knowledge versatility, adaptability to changing situations, discerning capacity, critical attitude, problem identification, and solution." 'Techniques and Time' defines technology as "organized inorganic matter"[2]. Technology is most broadly described as the material and immaterial entities formed by the application of mental and physical effort to accomplish some value. Technology refers to the application of scientific knowledge to everyday tasks. Technology is the science of procedures, or methods of doing and getting things done, in relation to any art, science, or profession. It is not just a specified methodology, but also a scientific method for developing new approaches. So, technology is more than simply machines and equipment; it is the expansion of human abilities, competencies, and talents in using machines and equipment to obtain information while overcoming time, space, cost, and effort barriers[3]. Teachers must be knowledgeable in the areas of technology, topic, curriculum, teaching methods, classroom management, learners and their characteristics, student learning evaluation, and techniques to evaluate instructional approaches [4]. The Technology, Pedagogy, and Content Knowledge (TPCK) theoretical framework provided by Mishra and Koehler supports this claim[5].

For effective technology adoption in the mathematics classroom, Mishra and Koehler advocated for instructors to have a well-developed integrated knowledge of technology, pedagogy, and subject. One of the most important steps in improving teachers' knowledge and skills in using technology to teach mathematics is to implement a professional development model in which they engage in technology-oriented activities[6][7]. Zhao, Tanand Mishra offered evidence to support the importance of teachers' attitudes regarding computer usage in the classroom and provided evidence to demonstrate that teachers' attitudes are directly related to use of computer in the classroom[8]. The attitudes of teachers, as well as their readiness to accept technology, will be critical to the success of student learning with computer technology[9]. The NCTM established the "Technology Principle" as one of the six principles of high-quality mathematics education, with recommendations and support for its usage[10].According to Principles and Standards of School Mathematics, "Technology is fundamental in the teaching and learning of mathematics; it changes the role of mathematics that is taught and promotes students' learning (p.24),"Teachers should use technology to improve their students' learning chances by selecting or inventing mathematical assignments that take use of what technology can accomplish efficiently and well-graphing, visualising, and computing. Furthermore, according to NCTM, appropriate use of technology can facilitate such applications by providing ready access to real data and information, making the inclusion of mathematics topics useful for applications and more practical (e.g. regression and recursion), and making it easier for teachers and students to combine multiple representations of mathematics topics.

Overview of teachers' attitude

The pedagogies used in the classroom are heavily influenced by teachers' attitudes regarding teaching mathematics at the secondary level. The inner perspective, opinion, ideas, feelings, and beliefs of a teacher are simply defined as their inner view, opinion, ideas, feelings, and beliefs regarding a specific phenomenon. The Kothari Education Commission correctly stated in its report that "India's destiny is being moulded in her classroom."It's not surprise that the teacher takes centre stage in India's vast opera of learning, which is performed virtually daily in Indian classrooms. There is a strong relationship between teachers' attitudes toward mathematics and students' attitudes toward the subject. If the teachers have a repulsive or negative attitude towards the subject, then that radiates a similar unfavourable attitude in the minds of the students as well as such negative attitude of the teacher might not only harm a pupils' academic performance but also heightens their psychological illnesses and physical stress symptoms.

Teachers' attitude towards mathematics

Teachers' attitudes about mathematics have a significant impact on their students' achievement. Teachers' pedagogy is influenced by experience, self-confidence, and motivation to teach the subject, according to the literature. Mathematical learning is influenced by a variety of circumstances. Three elements that influence teachers' opinions of mathematics teaching are- students have specific mathematical beliefs; second, they create views when they are frequently confronted with mathematics issues; and third, they experience interruptions and blocks when learning mathematics and this may result in both negative and good responses from the students[11]. The Attitudes Towards

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Mathematics Inventory (ATMI) is a well-known attitude detection tool [12]. The ATMI was designed by J. E. Schackow for mathematics teachers[13].Value (whether mathematical skills are worthwhile), enjoyment (if mathematical problems are fun to work with), self-confidence (how quickly mathematics is mastered), and motivation (the desire to acquire more understanding about the subject) are the four underlying dimensions.

Many studies have been, and rightfully continue to be, focused on the relationship between students' attitude toward mathematics and achievement [14][15][16][17][18]."Students' perceptions on learning this subject settled in their minds have to be changed by the concerned teachers and parents to develop a positive attitude towards the subject"[15] Despite the fact that mathematics is widely recognized as important, many people have a good or negative attitude toward it. Attitudes are an important aspect of a person's personality. To have feelings of love and hatred, preference and despise, favour and opposition, agreement and disagreement, argument and persuasion is perfectly normal. All these responses are directed towards an idea that can be evaluated. As a result, attitudes might be described as a general assessment of an object[19]. Attitudes toward mathematics encompass beliefs, talents, and perspectives on the subject's utility [20]. Beliefs to be rational in nature, with attitudes based on beliefs requiring the development and maintenance of mathematical and pedagogical knowledge and teachers must provide excellent instruction to their students. Teachers always involve by seeking out new sources of information, forming professional networks, and participating in professional development grows as professionals [10].

Teachers' attitude towards use of ICT

ICT (Information and Communication Technology) in education refers to the manner of education in which information must be generated and exchanged from people to people, and machines to machines. Any communication device, such as a radio, television, mobile phone, computer and network hardware and software, satellite system, and so on, as well as the numerous services associated with them, such as video conferencing and distance learning, are included in ICT. All human performances and interactions require communication in the form of transfer of thoughts, information, and commands between two or more individuals using the various infrastructure available, whether vocal (Oral) or non-verbal (Technological). Literacy in ICT is a current technology in the kingdom of education. ICT is a necessary tool in the modern classroom since it improves the efficiency of the teaching and learning process and allows material to be accessible and shared instantaneously. Teachers must be well-equipped with the knowledge they require in order to successfully convey knowledge to students.

The primary question is whether or not teachers have the necessary ICT skills. According to certain research, teachers do not obtain the requisite degree of knowledge. Rosnaini and Mohd Arif found that only a small percentage of teachers were proficient in fundamentals of ICT [21]. The majority of them only had a basic understanding of ICT or none at all. This example clearly demonstrates that improving teacher ICT knowledge is critical to the success of ICT programmes in schools[22]. The role of the teacher in a technology-based classroom is more difficult. The mindset and willingness of teacher educators to use ICT tools are critical to the effectiveness of ICT implementation and student achievement. The majority of research demonstrates that government interventions and training programmes help the teachers to develop the positive attitude toward ICT. Teachers were enthusiastic about using computers in the classroom[9]. This result is also consistent with the findings of several studies [23][24][25]. They looked at how potential secondary teachers felt about using computers and the Internet in general. The use of ICT in the classroom, particularly in the integration of a positive outcome, will be determined by the following factors: teachers' perceptions of ICT's contribution to mathematics education, students' perceptions of ICT's role in mathematics education, and arithmetic teachers' willingness to employ ICT in the classroom, Teachers' self-esteem and classroom administration's ability to incorporate ICT in education for teachers and attractions were positively affected by the presence of ICT in the classroom. According to Kumar and Kumar most teachers believe that computer expertise has a beneficial impact on attitudes toward computers[26].It is necessary for teacher educators to comprehend the factors that influence pre-service teachers' attitudes toward computers in order to build effective teacher training curricula that will educate teachers to confront the challenges of the information age [27]. In a study it was proposed that a positive attitude toward computer technology use had a positive link with intention

and, subsequently, real computer use in the classroom[28]. Teachers' attitudes regarding computer use will be the most important factor of technology use in the classroom in the future [29]. In a study of secondary school instructors, it was found that ICT usage in instruction leads to general usefulness; affective attitudes, behavioural control, and pedagogical use are all important factors in influencing ICT use[30].Teachers' perceptions and attitudes have been identified in the research as a key component in the integration of ICT in teaching and learning [31]. Teachers are expected to accept and use ICTs appropriately in their classrooms, thereby implementing the pedagogical improvements expected. Thus, the attitudes, perceptions, and skill of instructors in integrating ICT into the teaching process are crucial to its effectiveness. The present study is going to investigate the teachers' attitude towards teaching mathematics in digital and traditional classroom of secondary schools of Guwahati city.

MATERIALS AND METHODS

Hypotheses
H_{01}There is no significant difference between the teachers' attitude towards teaching mathematics in digital and traditional classroom.

H_{02}There is no significant difference between the teachers' attitude   towards teaching mathematics in digital and traditional classroom of SEBA (Board of Secondary Education Assam) school.

H_{03}There is no significant difference between the teachers' attitude towards teaching mathematics in digital and traditional classroom of CBSE (Central Board of Secondary Education) school.

Research method
The researcher adopted descriptive survey method to measure the attitude of mathematics teachers towards their teaching activities. The schools of Guwahati city are divided in two groups: Digital classroom and Traditional classroom. Digital classroom refers those schools where teachers use digital board and computer during teaching mathematics. Traditional classrooms are those where teachers use chalk board, textbook, models and charts during teaching. A5-point Likert Scale questionnaire comprising 20 items were administrated among the teachers for gathering the information regarding the teachers' attitude towards teaching mathematics. Responses are rated from five possible choices: strongly agree-5, agree-4, neutral-3, disagree-2and strongly disagree-1. In this way, the scores range from 20 to 100, a high score indicates higher level of positive attitude towards teaching mathematics in digital and traditional classroom.

Total Population of Teachers
The population of the present study are constituted working in both Government and Private schools under SEBA (Board of Secondary Education, Assam) and CBSE (Central Board of Secondary Education) (private only) belonging to Guwahati city of Kamrup (M) District, Assam. The four CBSE schools under central Government of Guwahati city are not taken into consideration because the teachers of these schools are not stable due to their transferrable job.

Sample Size Determination
In this present study, sample size for teachers is determined by using Cochran's formula at 95% confidence level with ±5% margin of error. In the study, 17 schools were already selected to study the students' attitude. But the teachers of these schools were not sufficient for the study to be undertaken. Therefore, the researcher had selected another 23 schools from Guwahati city to study the teachers' attitude towards teaching mathematics. In the present study, overall, 40 schools are selected randomly from each category such as SEBA(Govt.), SEBA(Pvt.) and CBSE(Pvt.) in which 14 are from Government SEBA; 12 are from Private SEBA and 14 are from Private CBSE schools in Guwahati city. The sample of 180 teachers (digital classroom=83, traditional classroom=97) selected from 40 schools is considered for the study.

Statistical tools Used

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Keeping in view the nature of the hypotheses of the study, the researcher used the following statistical techniques for analysing the data and testing of hypotheses.

1. One sample Kolmogorov-Smirnov Normality test, for testing if the data follows normal distribution or not.
2. Percentage analysis, in making comparison between two series of data.
3. Mean and Standard Deviation, to study the levels of teachers' attitude.
4. Mann Whitney Test, for testing the significance of difference between the teachers' attitude towards teaching in digital and traditional classroom.
5. Tukey Post Hoc test, to find out the paired mean difference and level of significance.

ANALYSIS AND DISCUSSION

The data are classified and then analyzed systematically and synthesized in such a way that the proposed hypothesis may be accepted or rejected. The final result may be considered as a new principle or generalization. In this study the researcher has presented the collected data and its interpretation by using statistical calculations with the help of Statistical Package for the Social Sciences (SPSS) and the required analysis was observed. From the table-3, it is observed that the data found are not normally distributed ($p < 0.05$). Histogram in figure-1 and box plot in figure-2confirms that the data is not normal which implies that resultant mean is not a representative value of our data. Therefore, non-parametric analysis is conducted which does not assume normality. The Man Whitney U test is used to compare two different groups.

Interpretation of Hypothesis H_{01}
There is no significant difference between the teachers' attitude towards teaching mathematics in digital and traditional classroom. The table-5 reveals the level of teachers' positive attitude as High, Moderate and Low in digital and traditional classroom. From the table, it is observed that 25.8% of teachers had high positive attitude, 45.4% had moderate positive attitude and 28.9% had low attitude in traditional classroom. Respectively 37.3% of teachers had high attitude, 37.3% had moderate attitude and 25.3% had low attitude in digital classroom. The table indicates that majority of teachers of digital classroom had high attitude than traditional classroom towards teaching mathematics. This implies that teachers in digital category had more positive attitude towards teaching mathematics. The table-6 reveals the mean Rank of teachers' attitude towards teaching mathematics in digital and traditional classroom.

From the table, it is observed that for97 observations in traditional category ,the sum of Ranks is 8419.50 and this result in a mean rank of 86.80. Respectively for 83 observations in digital category, the sum of Ranks is 7870.50 and this result in a mean rank of 94.83. From the table, it is clear that teachers of digital category have the higher mean rank than the traditional category. But the sum of Ranks in traditional category is higher than the digital category. Now the Test Statistics table will decide whether this difference in mean Ranks is significant or not in digital and traditional classroom. The table-7 indicates the U test statistic value as 3666.500. Wilcoxon W statistic quoted here represents the maximum of the two rank sums which is 8419.500. Here the calculated Z-value is -1.032and the p-value, quoted next to Asymp. Sig. (2-tailed) is 0.302 which is greater than 0.05.So, there is sufficient evidence to accept the null hypothesis that there is no significant difference between the teachers' attitude towards teaching mathematics in digital and traditional classroom.

Interpretation of Hypothesis H_{02}
There is no significant difference between the teachers' attitude towards teaching mathematics in digital and traditional classroom of SEBA schools. The table-9 reveals the mean Rank of teachers' attitude towards teaching mathematics in digital and traditional classroom of SEBA schools. From the table, it is observed that for 64 observations in traditional category, the sum of Ranks is 3645.50 and this result in a mean rank of 56.96. Respectively for 52 observations in digital category, the sum of Ranks is 3140.50 and this result in a mean Rank of 60.39. From the

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table, it is clear that teachers of digital category have the higher mean Rank than the traditional category. But the sum of Ranks in traditional category is higher than the digital category. Now the Test Statistics table will decide whether this difference in mean Ranks is significant or not in digital and traditional classrooms of SEBA schools. The table-10 indicates the Mann-Whitney U test statistic value as 1565.500. Wilcoxon W statistic quoted here represents the maximum of the two rank sums which is 3645.500. Here the calculated Z-value is -0.548 and the p-value, quoted next to Asymp. Sig. (2-tailed) is 0.584 which is greater than 0.05. So, there is sufficient evidence to accept the null hypothesis that there is no significant difference between the teachers' attitude towards teaching mathematics in digital and traditional classrooms of SEBA schools.

Interpretation of Hypothesis H$_{03}$

There is no significant difference between the teachers' attitude towards teaching mathematics in digital and traditional classroom of CBSE schools. The table-12 reveals the mean Rank of teachers' attitude towards teaching mathematics in digital and traditional classroom of CBSE schools. From the table, it is observed that for 33observations in traditional category, the sum of Ranks is 1011.50 and this result in a mean rank of 30.65. Respectively for 31 observations in digital category, the sum of Ranks is 1068.50 and this result in a mean Rank of 34.47. From the table, it is clear that teachers of digital   category have the higher mean Rank than the traditional category. The sum of Ranks in digital category is also higher than the traditional category. Now the Test Statistics table will decide whether this difference in mean Ranks is significant or not in digital and traditional classroom of CBSE schools. The table-13 indicates the Mann-Whitney U test statistic value as 450.500. Wilcoxon W statistic quoted here represents the minimum of the two rank sums which is 1011.500. Here the calculated Z-value is -0.822 and the p-value, quoted next to Asymp. Sig. (2-tailed) is 0.411; which is greater than 0.05. So, there is sufficient evidence to accept the null hypothesis that there is no significant difference between the teachers' attitude towards teaching mathematics in digital and traditional classroom of CBSE schools.

CONCLUSION

Several studies reveal the importance of teachers' positive attitude towards teaching mathematics in primary and secondary level and how it plays a significant role in pedagogical enrichment. Moreover, use of ICT in teaching and learning lead classroom sessions more effective, and thus teachers' engagement in this transition from traditional classroom to digital one matters their attitude towards respective type classrooms. In the study, under both of the government and private sectors, teachers' attitude towards teaching mathematics does not matter whether it is digital or traditional approach within the domain of study as no significant difference observed. However, junior teachers with an experience of 2 to 5 years have been found possessed positive attitude towards teaching mathematics in digital mode.

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Table 1: Distribution of total population in digital and traditional classroom from different category

Category	No. of Schools digitally equipped	No. of Teachers in Digital Classroom	No. of Schools with traditional classroom	No. of Teachers in Traditional Classroom
SEBA (G)	24	42	78	104
SEBA (P)	29	53	38	52
CBSE (P)	34	57	10	18
Total	87	152	126	174

Table 2: Distribution of sample of teachers in digital and traditional classroom from different category

Category	No. of Teachers			
	Digital Classroom (N_i)	n_i	Traditional Classroom(N_i)	n_i
SEBA (G)	42	23	104	57
SEBA (P)	53	29	52	29
CBSE (P)	57	31	18	11
Total	152	83	174	97

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Table 3: One sample Kolmogorov-Smirnov Normality test for teachers' attitude

Tests of Normality			
	Kolmogorov-Smirnov[a]		
	Statistic	df	Sig.
Total attitude	0.083	180	0.004
a. Lilliefors Significance Correction			

Table 4: Distribution of sample of teachers in digital and traditional classroom

	Digital-Traditional			Total
Digital		**Digital**	**Traditional**	
Traditional	**Count**	83	97	180
	% of Total	46.11%	53.89%	100%

Table 5: Classification of the sample according to the level of attitude towards teaching mathematics in traditional and digital classroom

	Category	High Attitude		Moderate Attitude		Low Attitude		Total	
		Count	%	Count	%	Count	%	Count	%
Digital-Traditional	**Traditional**	25	25.8	44	45.4	28	28.9	97	100.0
	Digital	31	37.3	31	37.3	21	25.3	83	100.0
	Total	56	31.1	75	41.7	49	27.2	180	100.0

Table6: Mann-Whitney U Test comparing the ranks of teachers' attitude towards teaching mathematics in traditional and digital classroom

Ranks				
	Digital-Traditional	N	Mean Rank	Sum of Ranks
Total Attitude	**Traditional**	97	86.80	8419.50
	Digital	83	94.83	7870.50
	Total	180		

Table 7:Test Statistics(a) for actual significance result

Test Statistics[a]	
	Total Attitude
Mann-Whitney U	3666.500

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Wilcoxon W	8419.500
Z	-1.032
Asymp. Sig. (2-tailed)	0.302
a. Grouping Variable: Digital-Traditional	

Table8: Distribution of sample of teachers in digital and traditional classroom of SEBA category

	Digital-Traditional			Total
		Digital	Traditional	
SEBA	Count	52	64	116
	% of Total	44.83%	55.17%	100%

Table9: Mann-Whitney U Test comparing the ranks of teachers' attitude towards teaching mathematics in traditional and digital classroom of SEBA category

Ranks				
	Digital-Traditional	N	Mean Rank	Sum of Ranks
Total Attitude	Traditional	64	56.96	3645.50
	Digital	52	60.39	3140.50
	Total	116		

Table 10:Test Statistics(a)for actual significance result

Test Statistics[a]	
	Total Attitude
Mann-Whitney U	1565.500
Wilcoxon W	3645.500
Z	-0.548
Asymp. Sig. (2-tailed)	0.584
a. Grouping Variable: Digital-Traditional	

Table 11: Distribution of sample of teachers in digital and traditional classroom of CBSE category

	Digital-Traditional		Total
	Digital	Traditional	
CBSE	Count	31	33	64
	% of Total	48.44%	51.56%	100%

Table12: Mann-Whitney U Test comparing the ranks of teachers' attitude towards teaching mathematics in traditional and digital classroom of CBSE category

Ranks				
	Digital-traditional	N	Mean Rank	Sum of Ranks
Total	Traditional	33	30.65	1011.50
	Digital	31	34.47	1068.50

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Attitude	Total		64		

Table13: Test Statistics (a)for actual significance result

Test Statistics[a]

	Total Attitude
Mann-Whitney U	450.500
Wilcoxon W	1011.500
Z	-0.822
Asymp. Sig. (2-tailed)	0.411
a. Grouping Variable: Digital -Traditional	
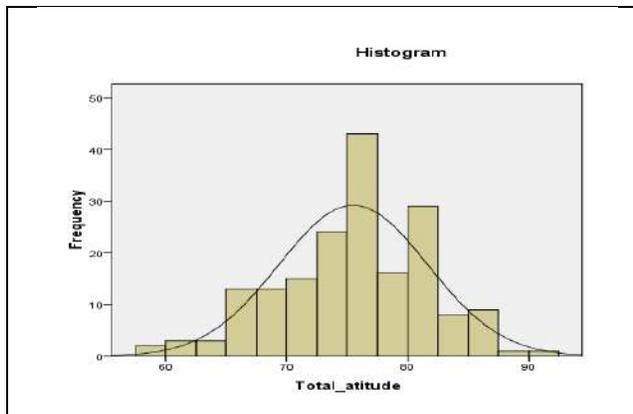
Figure 1: Teachers' attitude levels
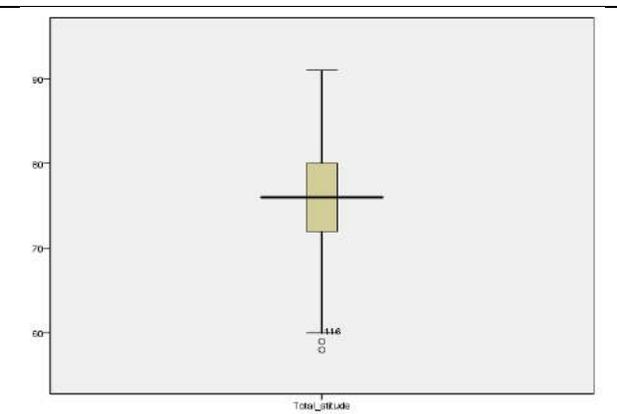
Figure 2: Boxplot of teachers' attitude
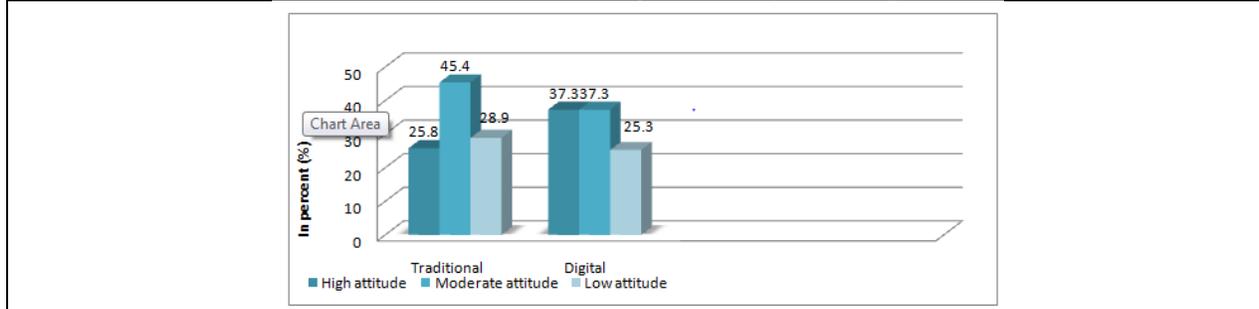
Figure3: Different attitude level of teachers in traditional and digital classroom

RESEARCH ARTICLE

Comparison of Salivary Calcium, Phosphorous and Alkaline Phosphatase among Xerostomia and Non-Xerostomia Patients- Comparative Study

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ABSTRACT

Xerostomia, a subjective feeling of dry mouth, is a serious concern with many ramifications observed in the oral cavity. Recognition of the features of xerostomia early by the dentist can help relieve the discomfort of the patient. Advances in research have made saliva to be used as a diagnostic fluid, as many of its components are considered potential biomarkers. The advantages of saliva testing over blood analysis involve the ease of collection, the non-invasive nature and the collection of multiple samples of saliva. This cross sectional study was carried out in Department of Prosthodontics at JSS dental college & hospital, Mysuru. A questionnaire was utilized to assess the perception of xerostomia in partially and completely edentulous patients. Random selection of 30 participants from xerostomia and non xerostomia group was done. Un stimulated whole saliva was collected from the participants. Biochemical assay of saliva samples for calcium, phosphorus and alkaline phosphatase was carried out in the Department of Biochemistry, JSS Medical Hospital, Mysuru. Lower mean values of salivary calcium and alkaline phosphatase levels were found in xerostomia participants than in non xerostomia participants and was statistically significant. Salivary phosphorous levels were higher in xerostomia but was statistically not significant. The variations in the levels of salivary calcium, phosphorus and alkaline

phosphatase in partially and completely edentulous patients were observed and xerostomia could have been one of the contributing factors.

Keywords: xerostomia, saliva, calcium, phosphorous, alkaline phosphatase.

INTRODUCTION

Saliva, produced by the major salivary glands – the parotid, sublingual & sub mandibular and the minor salivary glands, plays a vital role in the maintenance and preservation of oral health.(1) The composition of saliva consists of 99% water and other components. The other constituents include calcium, sodium, magnesium, potassium, bicarbonate, phosphates, proteins, immune globulins, enzymes like alkaline phosphatase, mucins, urea and ammonia. The estimated daily salivary flow ranges between 0.5 to 1.5 litres. (2) Xerostomia represents a subjective feeling of dry mouth whereas, hypo salivation represents an objective sign of dryness of mouth caused by hypofunction of salivary gland leading to production of decreased quantity of saliva. The quantity of saliva produced is assessed by sialometry. (3) Xerostomia has been associated with many factors. The most common ones are medications, psychological conditions, such as stress and anxiety; systemic diseases like diabetes, hypertension, cardiovascular disorders, head and neck radiotherapy and salivary gland disorders. The other causes include systemic sclerosis, rheumatoid arthritis, primary and secondary Sjogren's syndrome, HIV, systemic lupus erythematosus, chronic active hepatitis, renal dialysis and graft v/s host disease.(4-11)

The restorative needs of the geriatric patients provided by fixed and/or removable prosthodontics through rehabilitative procedures is dependent on the quality and quantity of available bone. Calcium, phosphorus and alkaline phosphatase, the chief mineral components of the skeletal system are also found as components of saliva. All these can serve as indicators of osteoblast function essential for bone formation. These salivary components have also been used to detect caries and periodontal disease activities. Salivary calcium has been used for screening osteoporotic patients for bone mineral changes and was proved to be an important tool. Salivary alkaline phosphatase has been tested as an additional tool in jaw growth predilection and oral potentially malignant disorders.(12-15) The quality and quantity of the available bone dictates the prosthodontic rehabilitation in case of the geriatric population. The conventional diagnostic procedures to assess the status of bone have utilized urine analysis or radiographic bone densitometry. A non-invasive approach to detect and assess the bone condition has remained a challenge for the health-care researcher. The increasing research on saliva as a diagnostic fluid in the recent years fulfills this criteria. Analysis of saliva for calcium, phosphorus and alkaline phosphatase, may be used as an effective diagnostic and screening procedure. This would aid in an early diagnosis and intervention strategy contributing to better and more predictable treatment outcomes. Hence the aim of the present study is to assess and compare the calcium, phosphorus & alkaline phosphatase levels in saliva in xerostomia and non xerostomia patients.

METHODOLOGY

This cross sectional study was carried out in Department of Prosthodontics at JSS dental college & hospital, Mysuru. Salivary analysis was carried out in laboratory at Dept. of Biochemistry, JSS Medical College, Mysuru. All the patients who gave informed consent were included for the study. Prior to the start of the study ethical clearance was obtained from Institutional Ethical Committee. A questionnaire was utilized to assess the perception of xerostomia in partially and completely edentulous patients. The following inclusion & exclusion criteria were considered for the selection of study sample. The inclusion criteria were Individuals aged 18 years or older, patients who gave informed consent, patients who had the ability to understand & provide answers to the questionnaire and Patients who were partially or completely edentulous. The exclusion criteria were patients diagnosed with salivary gland disorders and Sjogren's syndrome, patients with history of any radiation therapy and patients who could not understand the

questionnaire. A total of 234 participants answered the questionnaire. Participants answering 'yes' to dry mouth question were considered as xerostomia (test) group and those answering 'no' as non xerostomia (control) group.

Saliva collection and storage

Random selection of 30 participants from xerostomia and non xerostomia group was done. Unstimulated whole saliva was collected while the participants sat upright. The head was slightly tilted forward and the eyes open. The participants refrained from eating, smoking, or drinking for 1-2 hours before collection of saliva in a quiet room between 9.00 AM and 11.00 AM under resting conditions. They were instructed to use water to rinse the mouth with prior to the collection of saliva to remove any debris. Unstimulated salivary samples were collected by draining method (passive drooling). 2ml of whole saliva was collected in a dry and sterilized plastic centrifuge tube. (16) (Figure -1) After collection of saliva the tubes were fastened with a cap, labelled and were put into a zip lock pouch and placed in a freezer (2^0C to 4^0C). After 1 hour, all the samples in the zip lock pouch with ice cubes were shifted into a freezer and stored at - 80^0C (Dept. of Biochemistry, JSS Medical College, Mysuru) until analysis(Figure -2).

Biochemical analysis of saliva

Biochemical assay of saliva samples for calcium, phosphorus and alkaline phosphatase was carried out in the Department of Biochemistry, JSS Medical Hospital, Mysuru. The samples were removed from the refrigerator and thawed (Figure-3). Saliva was centrifuged at 2000 rpm for 10 min and the clear supernatant was obtained and subjected to biochemical analysis (Figure -4 - 6). The results were interpreted by a semi auto analyzer.

Estimation of in organics a livary calcium (colorimetric method) (17,18) –

Salivary calcium was assessed by modified Arsenazo III method. Calcium forms complex with arsenazo III dye, which is measured spectro photo metrically at a wavelength of 650 nm. The amount of the colored complex formed is proportional to the calcium concentration in the sample.

Estimation of inorganic salivary phosphorus by colorimetric method (19-22)

Salivary phosphate was measured using phosphomolybdate methodology. Inorganic phosphorus reacts with ammonium molybdate to form ammonium phosphomolybdate, which is measured at a wavelength of 340 nm.

Estimation of salivary alkaline phosphatase (23,24)

Salivary alkaline phosphatase was assessed by kinetic method. Alkaline phosphatase reacts with para nitrophenyl phosphate to form p-nitrophenol and inorganic phosphate, which is measured at a wavelength of 405 nm. The values of salivary calcium, phosphorus and alkaline phosphatase levels obtained were collated into excel sheet and statistical analysis was done. The mean values of salivary calcium, phosphorus and alkaline phosphatase of test group (non xerostomia) were compared with the mean values of control group(xerostomia).

Statistical methods

Mean, standard deviation, frequencies and percentage were used for descriptive statistics. Normality of the data was assessed using Kalmogorove Smirnove test and Shapiro-wilk test. Independent sample't' and test Chi-square test were applied. $P<0.05$ was considered to be statistically significant. Statistical analysis was done using SPSS software (version 23).

RESULTS

Table 1 describes the study sample characteristics of the study population. For the comparison purpose we have selected similar age group. The mean age and gender were found to be statistically not significant. Other variables smoking, alcohol, medication between xerostomia and non xerostomia was statistically not significant.

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The differences in the mean values of salivary calcium and alkaline phosphatase levels between xerostomia and non xerostomia groups were statistically significant. The mean salivary calcium level was 7.87 mg/dl in participants with xerostomia which was lower when compared to non xerostomia participants (8.92 mg/dl). The mean salivary phosphorus level in xerostomia group (5.61mg/dl) was higher when compared to non xerostomia group (4.50 mg/dl) but was not statistically significant. Salivary alkaline phosphatase values were statistically significant when compared between xerostomia (18.76 IU/L) and non xerostomia (38.45IU/L) groups. It was lower in participants with xerostomia compared to non xerostomia group(Table 2a & 2b).

DISCUSSION

Principally, saliva which is an indispensable fluid in the human body is frequently forgotten and people try not to look for help for it until the basic day-to-day functions like eating and speaking are affected. This study defined xerostomia as a subjective feeling of dryness of mouth in which hypo salivation may be one of the components However, it can also be accompanied by normal salivary flow rate. Hypo salivation was defined as a definitive decrease in salivary flow rate which is an objective measure. Calcium and phosphorus, the inorganic components of saliva, account for the main mineral component of the human skeletal system. Alkaline phosphatase which is secreted into the saliva also serves as a biochemical marker for bone turnover. (25) Xerostomia encompasses changes in composition of saliva and normal/reduced salivary flow rate. As the composition of saliva changes, it was assumed that the levels of these salivary biomarkers may also vary. Hence, an attempt was made to evaluate any changes in the levels of salivary calcium, phosphorus and alkaline phosphatase in partially and completely edentulous participants with xerostomia. This study involved collection of unstimulated saliva from the participants using the passive drool method. In a study by Navazeh et al it (26) was found that spitting and passive drool (draining) methods provided similar type of information about unstimulated whole saliva. Both these methods were found to be reliable and reproducible. After the collection of saliva, the samples were stored at -80⁰C until analysis was done. According to Bhattaraj KR et al (27) in their review state that samples can be stored at -80ºC for several years. They also mention that many samples stored properly for more than four years had shown little or no degradation. In the present study, it was found that salivary phosphorus was higher(statistically non significant), salivary calcium & alkaline phosphatase were lower(statistically significant) in participants with xerostomia(test group) when compared to non xerostomia(control group) participants.

To the best of our knowledge, the present study is the first study to assess salivary levels of calcium, phosphorus and alkaline phosphatase in partially and completely edentulous participants with xerostomia. The variations in the levels of salivary calcium, phosphorus and alkaline phosphatase could be secondary to the compositional change in saliva. It may also be attributed to many risk factors like systemic diseases, hormones (Eg: estrogen, PTH), medications, number of intact teeth present, salivary flow rate and salivary p^H . The management of xerostomia involves i) detecting and treating the causative factor if possible, ii) palliative treatment – local / systemic to increase the salivary flow iii) enforcing a dental program to decrease or completely remove the clinical consequences of xerostomia. (27) Guggneheimer et al suggested that the effects of xerostomia could be managed by combination of treatments and there was no one common cure to it. Various management techniques were collected and placed under three groups – palliative treatment, use of saliva substitutes, and cholinergic drugs. Palliative treatments included the use of salivary slow stimulants such as sugarless chewing gum, alcoholic beverages and mouth rinses, humidifiers when sleeping, Lozenges and sugarless hard candies. Saliva substitutes including carboxy methyl or hydroxyl methyl cellulose as contents were recommended. Cholinergic drugs were listed last, because they are not indicated in patients with cardiac disease, since they alter the cardiac conduction frequencies. (28) The limitations of the study were biochemical analysis of saliva with relation to calcium, phosphorus and alkaline phosphatase was carried out in a small sample. Research related to the estimation of salivary biomarkers in patients with xerostomia related to edentulism is further recommended. This is to establish the cause for the variations in the levels of salivary calcium, phosphorus and alkaline phosphatase.

CONCLUSION

The variations in the levels of salivary calcium, phosphorus and alkaline phosphatase in partially and completely edentulous patients were observed and xerostomia could have been one of the contributing factors. Further research is required to substantiate this finding.

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Table 1 : Characteristics of participants included in the study

groups	xerostomia	Non xerostomia	Inferential test value	p-value
Gender Men women	17(56.7) 13(43.3)	14(46.7) 16(53.3)	0.601	0.606 NS
Smoking Yes No Past smoker	5(16.7) 23(76.7) 2(6.7)	4(13.3) 25(83.3) 1(3.3)	0.528	0.768 NS
Alcohol Yes No previously	8(26.7) 20(66.7) 2(6.7)	10(33.3) 18(60.0) 2(6.7)	0.327	0.849 NS
Medication Yes No	16(53.3) 14(46.7)	10(33.3) 20(66.7)	2.443	0.192 NS
Gender	48.03(1.24)	47.60(1.30)	1.317	0.193 NS

Table 2a :Comparison of salivary calcium, phosphorous and alkaline phosphatase in non-xerostomia and xerostomia group

Variables	Groups	N	Mean	Std. Deviation	Std. Error Mean
Calcium	NX	30	8.9213	1.58415	.28922
	X	30	7.8711	2.51941	.47612
Phosphorous	NX	30	4.5080	1.58189	.28881
	X	30	5.6129	2.72926	.51578
Alkaline phosphatase	NX	30	38.4537	31.86677	5.81805
	X	30	18.7682	9.76327	1.84508

NX – Non xerostomia, X – xerostomia.

Table 2b : Test Statistics

	Calcium	Phosphorous	Alkaline phosphatase
Mann-Whitney U	230.500	332.500	229.000
Wilcoxon W	636.500	797.500	635.000
Z	-2.949	-1.362	-2.972
Asymp. Sig. (2-tailed)	.003	.173	.003

RESEARCH ARTICLE

Three Different Instructions for Better Pelvic Floor Muscle Contraction

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ABSTRACT

Pelvic floor muscles are the only muscles capable of increasing urethral closure pressure, lift the pelvic floor, and improve structural support. A correct pelvic floor muscle contraction (PFMC) may be difficult to perform. Several studies have shown that >30% of women are unable to contract their PFMs on their first attempt. Eleven primipara and multi para women with mean age participated in this study**.** A 6 MHz 35-mm curved linear array ultrasound transducer (Mindray M5) was placed in the transverse plane, supra pubically over the lower abdomen and angled at 15-30° from the vertical depending. Each participant received three verbal instruction s as to how to correctly contract the PFMs. The ANOVA show**s** that there exist no statistical significant difference in bladder neck movement between rest and Hold Urine instruction($p > 0.05$). there is a statistical significant difference in bladder neck movement between rest and Hold Urine and Hold motion instruction($p < 0.05$). there exist a statistically significant difference in bladder neck movement between rest and Hold urine, motion, contract vagina and lift up($p < 0.01$) **.**The findings suggest that out of the three verbal cues, best verbal instruction is" Tighten up and lift the muscles around the anus, vagina and urethra "which produces a statistically significant pelvic floor muscle function than the other two verbal cues. This study can influence and assist women's health and can produce more better result when done with a large sample size.

Keywords: Trans abdominal Ultrasound , pelvic floor muscle contraction..

Ponmathi and Uma

INTRODUCTION

Pelvic floor is a group of muscles comprising two layers , superficial perineal muscles and deep pelvic diaphragm that forms a sling at the base of pelvis. Pelvic floor muscles (PFM) plays an important role in supporting abdominal viscera other than its sexual and sphincter functions [1].PFM are capable of improving the urethral closure pressure and thereby increase the support [2]. .Pelvic floor muscle becomes disrupted during childbirth, constipation etc, also sedentary lifestyle, menopause also have an impact on function of pelvic floor(3).PFM muscles can voluntarily contract [3] and contraction of it elevates the bladder neck efficiently [4]. In 1948,PFM exercises was first introduces by Arnold Kegel and he found a good outcome with pelvic floor muscle function. He argued that restoring the function of pelvic floor would in turn increase the urethral closure pressure, thus preventing the involuntary loss of urine (5).It has the highest level of evidence in strengthening pelvic floor muscle. Women's health physiotherapist find making women to contract the muscle efficiently and correctly to be the most challenging aspect in training. Many researches have contributed to the lack of (4)awareness of the women in recruiting the muscle appropriately. Bo et al comments that PFM contracts in a mass, where as shafik, 1998 commented that there happens a compartmental recruitment of PFM [6].Different clinical methods have been used in pelvis floor muscle training across the literature, few are PFM contract is lift up not a depression. Few contractions encouraged are tuck in the abdominals, anal contraction and contraction of hip adductors. whereas in few research suggest gluteal contractions are inappropriate in pelvic floor muscle training(7–10). linically. PFM contraction may be facilitated through verbal cues. Till now there are lot of controversy regarding the appropriate cue used to facilitate a good pelvic floor muscle contraction. There are different published literature on this, Few important evidence on the cues used throughout the world are as below

	UK	USA	SOUTHERN HEMISPHERE
National surgical colleges	The Royal College of Obstetrics and Gynaecology "No public information on pelvic floor muscle contraction instruction" available www.rcog.org.uk	The American College of Obstetrics and Gynecology "squeeze the muscles that you use to stop the flow of urine'.	The Royal Australian and New Zealand College of Obstetrics and Gynecology "These muscles are the ones you normally squeeze when you try to stop wind escaping" www.ranzcog.edu.org UrinaryIncontinence A Guide for Women. Leaflet to order
National physiotherapy association	The Chartered Society of Physiotherapy "You should imagine that you are trying to stop yourself from passing urine and at the same time trying to stop yourself from passing wind"	The American Physical therapy Association "try stopping or slowing the flow of urine" www.apta.org "You can do something about incontinence. A Physical Therapists Prospective"	The Australian Physiotherapy Association "Tighten up and lift the muscles around the anus, vagina and urethra"
Published physiotherapists	"squeeze and lift the pelvic floor muscles as if preventing the escape of flatus and/or urine" (Laycock et al.)10	"pucker the anus, vagina, and urethra" (Carrie` re)11	"draw in, close around the vagina and lift the pelvic floor towards your head" (Sapsford et al.)7 "squeeze and lift your pelvic floor" (Frawley et al.)12

There is a wide variety of belief and question exist on appropriate verbal cue instruction around the world .Different thoughts like if verbal cues should involve pelvic floor muscles contraction around vagina, rectum and urethra or should involve only one region like contraction around urethra or vagina or rectum or whether trans versus ab dominis or breathing to be incorporated in cues and so on [11]. In India there is no common cue followed in common and lot of different thoughts exist. Pelvic floor muscle function is commonly assessed by digital palpation and clinical observation(12)With evolving research two dimensional ultrasound provided a better understanding of pelvic floor muscle function [13]. Trans abdominal ultra so no graphy (TAUS) is found to be safe and cost effective. It is also a quick and reliable method of assessment of pelvic floor muscle function [14]. In this study, three different

cues were chosen to find their individual effectiveness over the pelvic floor muscle function. Various verbal instructions prevailing globally to make the patient contract pelvic floor muscles, In India also diverse verbal cues exist, yet it is still under debate in research literature to say which verbal cue better recruit the pelvic floor and least studies exist among Indian population. Hence this study is performed to promote the awareness and improve pelvic floor muscle function, further this would help physiotherapist to instruct for better outcome of the patient.

MATERIALS AND METHODS

Observational study design The patients were recruited from the outpatient department of Obstetrics and Gynaecology , SRIHER G block, Chennai. A total of 11 participants were included in this study. Convenient sampling was done. Primipara and multipara women. Age- 20 to 40 years were included in this study ,patients with congenital anomalies, pregnancy and neurological conditions were excluded from this study.

PROCEDURE

In this study, 11 postnatal women both primi and multipara who fulfilled the inclusion and exclusion criteria were recruited from OBG department, G block, Sri Ramachandra hospital for this study. All the women were explained about the importance of the study and investigation procedure and informed consent was obtained. The rights of the subjects were protected. Then the women were asked to complete a self reported questionnaire and were explained about the three different instructions and was made sure that all the women understood the instructions properly and then all the women were made to undergo a non- invasive trans abdominal ultrasound (TAUS) with three appropriate different instructions. First resting bladder neck was measured with TAUS and then first instruction was verbalized and scan was taken once the women did it and second verbal cue was said and scan followed it, then at third verbal instruction was given following which scan was taken.

Procedure of TAUS
This procedure was done by Radiologist, G block,Sri Ramachandra Hospital. To image the pelvic floor, a 6MHZ 35-mm curved linear array ultrasound transducer (Mindray M5) was placed in transverse plane, supra pubically over the lower abdomen, and then angled at 15-30° from the vertical line. A bladder filling protocol was implemented to ensure that the patients had sufficient fluid in their bladders to allow clear imaging. This entailed subjects consuming 600-750 mL of water during a 1-h period and completing the task half an hour prior to the testing time.

Instructions
The patients were given three different verbal instructions as to how to contract their PFMs.

Instruction 1: ''Try stopping or slowing the flow of urine"

Instruction 2 :You should imagine that you are trying to stop yourself from passing urine and at the same time trying to stop yourself from passing wind''

Instruction 3 :Tighten up and lift the muscles around the anus, vagina and urethra''
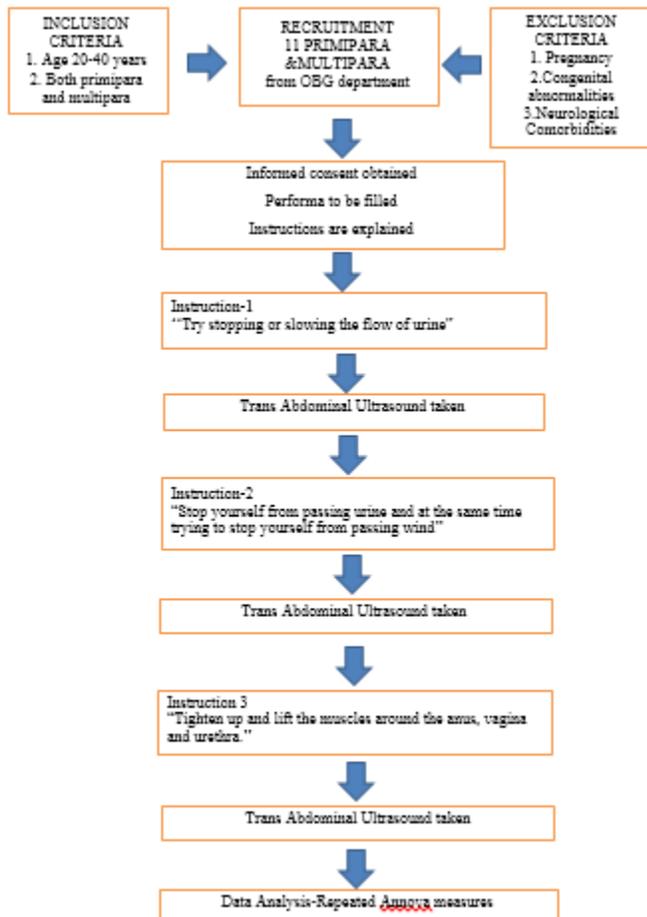
RESULTS

- 11 samples are recruited and demographic details are tabulated in Table 1
- Mean baseline value ,movement with three different instructions are documented in Table 2 .
- Table 3 shows that there exist no statistical significant difference in bladder neck movement between rest and Hold Urine instruction($p>0.05$).
- Table3 shows that there is a statistical significant difference in bladder neck movement between rest and Hold Urine and Hold motion instruction($p<0.05$).
- Table 3 shows that there exist a statistically significant difference in bladder neck movement between rest and Hold urine, motion, contract vagina and lift up($p<0.01$)
- Table 4 shows the mauchly's sphericity as non-significant ($p>0.05$)
- Figure1:Transabdominal Ultrasound findings after three different verbal cues for pelvic floor muscle contraction
- Figure 2 shows the mean distribution of the age <25 is 9.09%, 25-30 is 27.27%, 31-35 is 45.45, 36-40 is 18.18%.
- Figure 3 shows the mean distribution percentage of BMI 20-27 is 81.82%, 28-35 is 9.09%, 36-40 is 9.09%.
- Figure 4 shows the mean distribution percentage of parity primipara is 45.45%, multipara is 54.55%.
- Figure 5 shows the mean distribution percentage of mode of delivery SVD is 81.82%, LSCS is 18.18%
- Figure 6 shows the mean distribution percentage of number of deliveries 1 is 54.55%, 2 is 27.27%, 3 is 18.18%

DISCUSSION

According to research ,most of the women contract PFM wrongly and lack of awareness about the importance of pelvic floor is quite high, so while incorporating PFMT verbal cues become one of the important section in the success of the training imparted. Still an uncertainty prevails worldwide regarding the correct verbal cue to facilitate effective pelvic floor muscle function. So this study is done to find the effectiveness of three different verbal cues coined by three different societies of physiotherapy- American Physical Therapy Association ("Try stopping or slowing the flow of urine"),Chartered Society of Physiotherapy("Imagine to stop yourself from stopping urine and at the same time trying from passing wind"),Australian Physiotherapy Association("Tighten up and lift the muscles around the anus, vagina and urethra")(15) over the pelvic floor muscle function. Taking into considerations all the literature data, as well from our observations, we have made an attempt to evaluate demographic factors which influence the pelvic floor function. we had considered Body mass index, Mode and number of delivery. Women with different categories of BMI were included in this study, on comparing various categories of BMI with the bladder neck mobility the obese population showed a less bladder neck mobility which is supported by Edyta Horosz et al, in 2020 who documented that Lower bladder neck mobility is associated with increased BMI and urethral length, but with such small sample we cannot derive any conclusions, It shows the way for future research. Vaginal delivery is associated with the increased bladder neck mobility when compared to the LSCS. And also Multi para shows poor pelvic floor muscle function than primipara . In this study out of 11 samples , 5 primi para and 6 multipara women were recruited, out of which three women did not show any pelvic floor muscle function(i.e)no bladder neck displacement even with all three instructions. Physiologically parity place an undue stress over pelvic floor muscle function which demands other pelvic floor muscle training protocol other than voluntary contraction like stimulation or biofeedback to benefit the patient. In comparison with the mode of delivery and the contractions there were a greater number of vaginal delivery than the Lower Segment Cesarian section in this study.

There is a mounting evidence that some cases of pelvic organ prolapse may be caused by trauma to the levator ani muscle(16). These injuries are not evident at the time of vaginal delivery. Literature quotes that compared to the spontaneous vaginal delivery, cesarean delivery was associated with significantly lower hazard for pelvic floor muscles while vaginal delivery was associated with significantly associated with anal incontinence and pelvic organ prolapse due to the pelvic floor muscle weakness. But in this study women with LSCS also shows poor pelvic floor muscle function which needs further research with a greater sample sizeThe results of this study shows that Hold Urine instruction cannot produce a significant difference in pelvic floor contraction than rest (p>0.05).The result of this study is in contradictory with Henderson et al, who documented that women are able to better contract the pelvic floor muscles with a simple cue of "Hold Urine". This can be better explained by that pelvic floor muscles is a sling based arrangement with puboviscertalis and puborectalis,this verbal cue only recruits the pubovis ceralis and leaving puborectalis and iliococcygeus to be recruited sub maximally which may influence the pelvic floor muscle function. Hold Urine and Motion widely accepted by CSP(Chartered Society of Physiotherapy) gave a good difference in bladder neck mobility after contraction(p<0.05). In this cue ,pubovisceralis and puborectalis are recruited maximally(12).When contracting rectum, iliococcygeus produce cranial lift of posterior region of levator ani thus producing effective pelvic floor muscle function than the first verbal cue. Third instruction "Tighten up and lift the muscles around the anus, vagina and urethra.'' is found to elicit a significant bladder neck movement than the other two cues thus able to produce a better pelvic floor function than the other verbal cues(15).This result goes in hand with KayCrotty who concluded that angle of urethral inclination is more acute when Posterior or posterior with anterior cue given. Thus with the above comment both pubovisceralis and puborectalis contract together effectively giving an efficient recruitment of pelvic floor muscles completely(4). Through out the world different cues are followed to enhance pelvic floor muscle function. This study will surely add benefit to the patient by better influencing pelvic floor muscle function and adding quality to their life.

CONCLUSION

Our findings suggest that out of the three verbal cues, best verbal instruction is" Tighten up and lift the muscles around the anus, vagina and urethra "which produces a statistically significant pelvic floor muscle function than the other two verbal cues. This study can influence and assist women's health and can produce more better result when done with a large sample size.

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TABLE 1: DEMOGRAPHIC DETAILS

CHARACTERISTICS	MEAN	STANDARD DEVIATION
Age	31.36	4.8
Height	161.09	7.3
Weight	63.25	12
BMI	22.31	6.6

OBSTETRIC HISTORY	N (%)
Primipara	5(45.45%)
Multipara	6 (54.54%)
MODE OF DELIVERY	N(%)
SVD	9 (81.8%)
LSCS	2 (18.1%)

TABLE 2

DESCRIPTIVE STATISTICS OF TRANSABDOMINAL SCAN REPORT DETAILS FOLLOWING THREE DIFFERENT VERBAL INSTRUCTIONS.

Instructions	N	Mean	SD
Baseline	11	16.00	0.000
Hold Urine	11	14.82	1.471
Hold Urine and Motion	11	14.55	1.036
Contract all(urine,motion vagina) and lift up	11	14.36	0.924

TABLE 3

PAIRWISE COMPARISON –WITHIN GROUP ANALYSIS OF ONE FACTOR AGAINST THE OTHER

Instructions	Instructions	Mean difference	Std.Error	P value
0	1	1.182	0.444	0.142
	2	1.455	0.312	0.005
	3	1.636	0.279	<0.001

TABLE 4:
MAUCHLY'S TEST OF SPHERICITY:

Within subjects effect	Mauchly's w	Approx. chi-square	Dif.	P value	Greenhouse geisser	Huynh-feldt	Lower-bound
Instructions	.408	7.811	5	.169	.690	.873	.333

FIGURE1: TRANSABDOMINAL ULTRASOUND FINDINGS AFTER THREE
DIFFERENT VERBAL CUES FOR PELVIC FLOOR MUSCLE CONTRACTION

FIGURE 2 : MEAN DISTRIBUTION OF AGE

FIGURE 3: MEAN DISTRIBUTION OF BMI
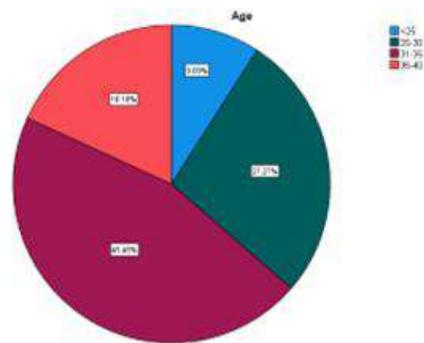
FIGURE 4 : MEAN DISTRIBUTION OF PARITY
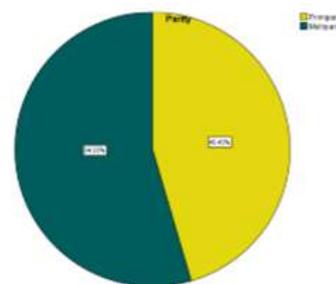
FIGURE 5 MEAN DISTRIBUTION OF MODE OF DELIVERY
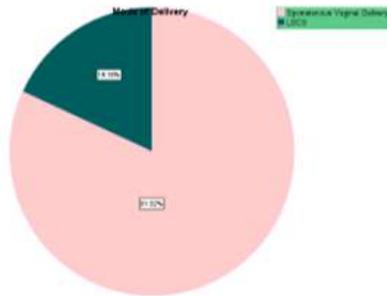
FIGURE 6- MEAN DISTRIBUTION OF NUMBER OF DELIVERY

RESEARCH ARTICLE

Antimicrobial Agents Utilization in the General Intensive Care Unit of a Secondary Care Referral Hospital in South India

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ABSTRACT

Antimicrobial utilization research is critical, especially in the general intensive care unit of hospital setting where the risk of bacterial resistance establishment and transmission is greatly increased. Long-term surveillance and stewardship of antimicrobial agents will reduce resistance while increasing effectiveness. However, Indian literature on this subject is scarcely available. Thus, the current research study was designed to assess the antibiotic utilization in a seven-bedded general intensive care unit of a secondary referral healthcare setting in south India. Measuring drug utilization in prescribed daily dose corresponded to the defined daily dose is proposed by the WHO to analyze and compare the utilization of drugs. Our study observed two-third distribution of female with mean age of 35 years. The study included 100 patient prescription with a total of 216 antimicrobial agents in orthopaedics, obstetrics and gynaecology, general medicine and general surgery as indications for admission; with mean antimicrobial per prescription of 2.01. 96.35% of antimicrobial agents were generic prescription with 93.81% of parenteral route of administration. The most common antimicrobial agent prescribed in our study on an average was ceftriaxone (34.97%)found no discrepancies between prescribed daily doses and WHO defined daily doses.

Keywords: Antimicrobial agents, General Intensive Care Unit, Defined Daily Dose, DUS metrics, Pharmaco surveillance.

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INTRODUCTION

The introduction of antibiotics into clinical practice revolutionized the treatment and management of infectious diseases. Before the introduction of antibiotics, these diseases were the leading cause of morbidity and mortality in human populations [1].In addition to treating infectious diseases, antibiotics made many modern medical procedures possible, including cancer treatment, organ transplants and open-heart surgery. However, misuse of these valuable compounds has resulted in the rapid rise of antimicrobial resistance (AMR) with some infections now effectively untreatable [2] and hampered by the lack of access to essential antibiotics in many low-income and middle-income countries (LMICs) [3,4]. The burden of infectious diseases in India is among one of the highest in the world [5]. Appropriate antimicrobial therapy is essential to ensuring positive patient outcomes. Inappropriate or suboptimal utilization of antibiotics can lead to increased length of stay, multidrug-resistant infections, and mortality [6]. It is axiomatic that hospital admissions increase risks of healthcare-associated infections (HCAIs), leading to a noticeable increase in antibiotic consumption [7]. In the hospital's intensive care units (ICU), the severity of the diseases treated and the multiple interventions to the patients are expected a high antimicrobial use [8]. However, Indian literature on this subject is scarcely available. Thus, the current research study was designed to assess the antimicrobial utilization in a seven-bedded general intensive care unit of a secondary referral healthcare setting of south India.

MATERIALS AND METHODS

Study design
Prospective Observational drug utilization study
Study site
Seven-bedded general intensive care unit(GICU) of 340 bedded secondary referral hospital in south India.
Study duration
Six months (October 2022 to March 2023)
Study Criteria
Patient of both genders of age 15 years and above admitted in GICU, in whom at least one antibiotic is prescribed with following indications (OBG, Orthopaedics, General Medicine and General Surgery).
Sample size
Fischer's exact formula was used to calculate the sample size of 100 in a 7 bedded GICU of our study.
Formula $n = z^2 X\ pq\ /\ d^2$
Z = Level of confidence, p = Expected prevalence, q = (1-p), and d = precision.

Study Procedure
Data collection
The study was approved by the institutional review board (IRB) (RIPER/IRB/PP/2022/004) and hospital's ethics committee (IEC). During the study period (October 2022 - March 2023) patient admitted in GICU as per study criteria particulars are retrieved from medical record through obtaining informed consent explaining the merits and demerits of study. Patients showing willingness are included for antimicrobial agent sutilization during the length of stay. All the data obtained are documented in the data collection form. Particulars of data collected from individual patient (prescription) are the following: patients age, gender and registration number; diagnosis, prescription details like number of drugs, names of individual drugs (generic/brand or both), any fixed dose combination (FDC) prescribed, whether the prescribed drug(s) was available from the hospital pharmacy, dose, dosage form, dosing schedule, and duration of treatment.

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Data analysis
The data analysis was done as follows**:** (a) Assessment of prescription patterns as per the WHO-INRUD drug use indicators [9], (b) Pattern of antimicrobial agents used as per DUS metrics [10], (c) The prescribed drugs will be classified according to The Anatomical Therapeutic Chemical (ATC) - Defined Daily Dose (DDD) classification [11], (d) The Prescribed Daily Dose (PDD) will be calculated by taking the average of the daily doses of the antibiotic drugs as the PDD. The PDD to DDD ratio will be then calculated.

RESULTS

Characteristics of study participant
In our prospective observational study of a 7 bedded general intensive care unit, the distribution of patients with indications of orthopaedics, obstetrics and gynaecology, general medicine and general surgery were 3 (3%), 28 (28%), 46 (46%), and 23 (23%) respectively. Out of 100 patients admitted in the general intensive care unit two-third (66%) were female population, majorly distributed with all indications except orthopaedics. The mean age distribution were observed more with indications of general medicine and general surgery, results of which are thoroughly analyzed and the relative distribution is reported in Table 1.

Pattern of antimicrobials utilization
In our study a total of 216 antimicrobials were prescribed out of 100 prescriptions. The distribution of antimicrobial utilization with general medicine indication was more (44.91%) with a mean of 2.1% per prescription, followed by general surgery indication with (28.7%) antimicrobial utilization and a mean of 2.7 per prescription. The percentage of antimicrobial as generic and as injections was well established with all indications of admissions; results of which are summarized in Table 2.

Antimicrobials utilization
Out of 216 antimicrobials utilized in our study, ceftriaxone was the most commonly used antimicrobial agent in all indications orthopaedics (75%), obstetrics and gynaecology (45.28%), and general medicine (19.59%); followed by piperacillin and tazo bactum with a distribution of 30.65% and 19.59% in general surgery and general medicine indications; results of which are thoroughly analyzed, and the relative distribution is reported in Figure 1.

Pattern of antibiotics utilization as per the WHO ATC/DDD classification
Bacterial resistance occurs in a higher proportion when they are administered in inadequate doses (e.g., when posology was prescribed in doses below the therapeutic ranges or during periods too short) [12]. As previously stated, these two components of prescription posology are dependent on both the prescriber and the patient; thus, this study evaluates the prescriber indirectly by comparing PDD values to their equivalent DDD values. Detailed quantitative and qualitative knowledge of antimicrobial use is essential to implement approaches for limiting deviations and threats in utilization of antimicrobials. The Prescribed Daily Dose (PDD) was calculated by taking the average of the daily doses of the antibiotics as the PDD. The PDD to DDD ratio was then calculated. In our study, the average PDD corresponded to the DDD for antimicrobials utilized in the general intensive care unit, results of which thoroughly analyzed and reported in Table 3.

DISCUSSION

Antimicrobials use data must be validated in order to identify high-use areas and provide feedback to prescribers [13], to research the relationship between antibiotic use and resistance, to develop and evaluate medicines, and to identify which intervention is most likely to be beneficial in a healthcare setting [14]. Benchmarking is an important initial step to identify problem areas and needs for improvement [15]. Despite its shortcomings, an international antimicrobial utilization unit, the WHO-defined DDD, is a useful tool for comparing local, national, and international

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antimicrobial use densities in hospitals. The demographic distribution observed in the general intensive care unit showed two-third distribution of female (66%) than male (34%), findings of which are similar with study performed by Demoz et al.,2020 [16] and contrast with other findings [17-20]. The mean age of patients was around 35 years which was nearly equal for both males and females. Studies done previously in Nepal in 2002 [17], Bengaluru in 2006 [18], and Dehradun in 2012 [19]. In the prescription audit, the average number of drugs per prescription is an essential measure. To decrease the likelihood of drug interactions, the number of drugs per prescription should be kept to a minimum. It will help reduce hospital costs and bacterial resistance [21].

A total 216 antimicrobial agents prescribed in our study during the whole study period, by taking an average it comes 2.01 per patient in the general intensive care unit. Other studies support our finding with an average of 2.09 [22] and 1.74 [19] respectively. In our study, majority of the antibiotics were prescribed as generics (96.35%) which helped in decreasing the overall cost of therapy; which washighest in comparison to study performed by Sushmita Ann et al., 2020 [23]. Antibiotics are commonly administered intravenous (IV) medications and is advantageous in the intensive care unit. In our study 93.81% of antibiotics were administered by intravenous route, relatively higher in comparison to study performed by Anand et al., 2016 [24].The most common antimicrobial agent prescribed in our study on an average was ceftriaxone (34.97%) in the general intensive care unit, this is in accordance with the similar studies by John et al., [18] 23.8% and Anand et al., [24] 22.77%. In our study, the ratio of PDD: DDD of antimicrobials prescribed in the general intensive care unit with indications of orthopaedics, obstetrics and gynaecology, general medicine and general surgery of admissions found no discrepancies between prescribed daily doses and WHO defined daily doses.

CONCLUSION

In conclusion, our study showed that the number of DDD correctly reflect the number of antimicrobial therapies at the general intensive care unit of our hospital. Long-term surveillance and stewardship of antimicrobial agents will reduce resistance while increasing effectiveness.

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Table 1. Characteristics of study participant

Indications for admission in GICU	Age distribution (Mean $\pm$ SD)
Orthopaedic	26.34 $\pm$ 7.41
Obstetrics and Gynaecology	34.39 $\pm$ 16.19
General medicine	36.39 $\pm$ 13.9
General surgery	36.35 $\pm$ 18.53

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Table 2. Pattern of antimicrobials use as per WHO-INRUD drug use indicators

WHO – INRUD drug use indicators	Indications for admission in general intensive care unit			
	Orthopaedics	Obstetrics and Gynaecology	General Medicine	General Surgery
Total number of prescriptions handled	3	28	46	23
Total number of antimicrobials prescribed	4	53	97	62
Average number of antimicrobials per prescription	1.34	1.89	2.10	2.70
Percentage of antimicrobials prescribed by generic name	100	100	88.65	96.77
Percentage of antimicrobials prescribed as an injection	100	96	82.47	96.77

Table 3. ATC/DDD Classification and DUS Metrics of antimicrobials used in GICU

Indications for admission	Antimicrobial agents	ATC/DDD Classification and DUS Metrics			
		ATC Code	PDD	DDD	PDD:DDD
Orthopaedics	Ceftriaxone	J01DD04	2	3	0.67
Obstetrics and Gynaecology	Ceftriaxone	J01DD04	2	24	0.0833
	Metronidazole	J01XD01	1.5	23	0.0652
General medicine	Ceftriaxone	J01DD04	2	19	0.1052
	Piperacillin + tazobactum	J01CR05	18	24.43	0.7368
General surgery	Piperacillin + tazobactum	J01CR05	18	24.43	0.7368
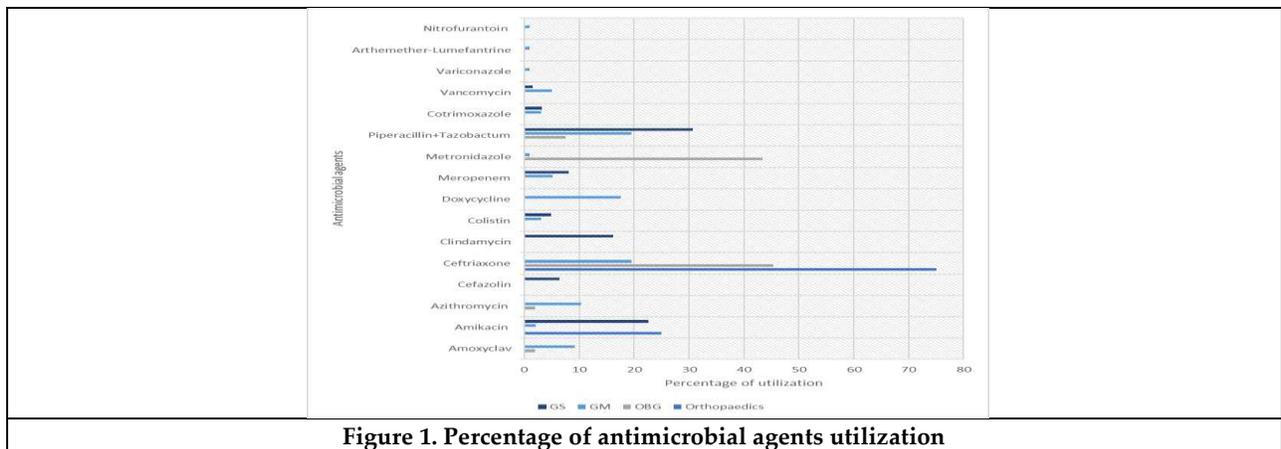
Figure 1. Percentage of antimicrobial agents utilization

RESEARCH ARTICLE

Evaluation of Pharmacognostical, Phytochemical and *In-vitro* Antioxidant Activity of *Lycopersicon pimpinellifolium* L.

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ABSTRACT

Lycopersicon pimpinellifolium L commonly known as "wild tomato" has significant nutritional and medicinal values. The plant has remarkable industrial application. The aim of this work is to assess the pharmacognostical, phytochemical screening and *in-vitro* antioxidant activity of fruit extract of *Lycopersicon pimpinellifolium* L .The methanolic extract of *Lycopersicon pimpinellifolium* L was screened for its pharmamacogonostical properties. The extract was further evaluated for the presence of phenols, flavonoids, saponins and tannins. The *in-vitro* antioxidant activity of fruit extract was evaluated by using DPPH, Hydrogen peroxide (H_2O_2) and Reducing power free radical scavenging assay. The fruit extract of *Lycopersicon pimpinellifolium* L showed presence of phenols, flavonoids, saponins and tannins. The total phenolic and flavonoid content of the extract were found to be 19.86mg GAE/g and 21.25mg QUE/g, respectively. The drug BHT was used as a standard. In DPPH a strong antioxidant effect is indicated by the highest 42.38% inhibition reported at 100μg/ml concentration. In Hydrogen Peroxide scavenging activity, the IC_{50} value of standard (BHT) and extract is found to be 69.65μg/ml and 242.20μg/ml, respectively. In Reducing assay method, reducing power of extracts and standard increases with the increase in amount of sample and standard concentrations. According to our research, methanolic extract

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of *Lycopersicon pimpinellifolium* L showed potential antioxidant activity and this would be due to the presence of polyphenols and flavonoids and may one day be the basis for new medications.

Keywords: DPPH, phenol, flavonoid, *Lycopersicon pimpinellifolium* L , H_2O_2.

INTRODUCTION

In contemporary times, medicinal plants have been widely employed for both preventive and therapeutic purposes. Herbal medicine possesses lesser negative effects than synthetic drugs which has evolved researchers to investigate developing new drugs made from plant species to treat various diseases. Numerous chemical constituents that are termed as phytochemicals or secondary metabolites are present in the plant species including flavonoids, phenols, alkaloids, steroids, tannins, sugars, and glycosides. These phytochemicals of plant contribute as defense against infections, microorganism and stresses related to an environmental. So, phytoconstituents/phytochemical are essential in the production of pharmaceutical products and serve as a starting point for the development of novel drugs as they possess a variety of pharmacological effects including those that are anti-cancer, anti-mutagenic, anti-inflammatory, wound-healing, anti-diabetic, and anthelmintic [1].

An antioxidant is a naturally or artificial occurring compound that is helpful in preventing oxidative damage. An antioxidant is a substance that has ability to preserve cells by scavenging and neutralizing dangerous free radicals and regulates Reactive Oxygen Species. Antioxidants have a significant role in the organism's defence mechanism against diseases linked to the attack of free radicals [2,3]. Oxidative stress acts as one of the key initiating factors in the occurrence of a variety of chronic and degenerative diseases, including immunological dysfunction, cancer, Parkinson's disease, diabetes mellitus, atherosclerosis, and diabetes. Synthetic and natural antioxidants can be used to scavenge free radicals, promote their elimination, and reduce those diseases. The use of herbal sources as natural antioxidants has gained prominence. The wide range of the antioxidant capacity of many plants is considered to be contributed by phenolic chemicals, which are rich in many fruits, vegetables, and tea [4].

Lycopersicon pimpinellifolium L (Family- Solanaceae) popularly called as Currant Tomato *Lycopersicon pimpinellifolium* L has overgrown bushes, small red fruit distributed across the dry coastal region of Peru, Ecuador, and northern Chile, where plants frequent exposure to salt-laden mist, brackish groundwater, and other unfavourable conditions. The fruits of *Lycopersicon pimpinellifolium* L are spherical, crimson in colour and sweet in taste, however they are much smaller and lighter than the larger, cultivated tomatoes. One of the most potent naturally occurring antioxidants i.e., lycopene is present in the *Lycopersicon pimpinellifolium* L (fruits). Lycopene, an antioxidant present in cooked tomatoes has reported to protect against prostate cancer cause due to Ultra Violet (UV) radiation. Over 40 times more lycopene is present in *Lycopersicon pimpinellifolium* L than in cultivated tomatoes [6]. *Lycopersicon pimpinellifolium* L (fruit) is abundantly consumedand flavoured vegetable crops worldwide both for the fresh fruit market and the processed food business. Its ability to adapt to a wide range of uses and habitats is a tribute to the genus Solanum's considerable genetic variety, which can be applied in breeding programmes. The systematic study and assessment of tomato germplasm is vital for the crop's current and future agricultural and biological development. The tomato fruit includes a variety of bioactive substances that have beneficial effects for individual health, including lycopene (LYC), beta-carotene (b-CAR), total polyphenols (TP), and ascorbic acid (vitamin C) Numerous carotenoids (CARs) are found in *Lycopersicon pimpinellifolium* L [7].

The main source of LYC in the human diet is found in tomatoes most likely prevent and lower the occurrence of chronic degenerative diseases through the antioxidant qualities of LYC and -carotene in connection to quenching reactive oxygen species (ROS). In addition to CARs, a variety of phenolic compounds enhance the functional and sensory properties of tomatoes as well as their health value [8].

MATERIALS AND METHODS

Collection and identification of the plant material

Fresh fruits of *Lycopersicon pimpinellifolium* L were collected from the district of Morigaon, Assam in the month of February. The authentication was carried out by preparing standard herbarium specimen and authenticated by scientist, Dr.N.Odyuo, Botanical Survey Of India, Eastern Regional Centre, Laitumkhrah, Shillong, Meghalaya with accession/No:BSI/ERC/Tech/2023-24/962. Fruits were washed thoroughly with running tap water, chopped into two equal halves, shade dried, pulverized and sieved with 60 number mesh size. The samples were stored in a sealed protected plastic container.

Extraction

The extraction was carried out by maceration method. The pulverized powder was extracted with 100% methanol (50g dried powder in 500ml methanol) which was then allowed to stand for 4-7 days at room temperature. The aqueous methanolic extract was filtered and concentrated to semisolid mass by using rotary vacuum evaporator and kept at 4∘C. The concentrated extracts were re-dissolved in aqueous methanolic solvent & subjected to chemical test for the identification of the various phytochemical screening [9].

Determination of total ash value

An estimated 2gm of *Lycopersicon pimpinellifolium* L powder were placed in a tarred silica crucible dish that had been weighed previously and was incinerated at temperature at 450∘C in a muffle furnace until it was white, signifying the lack of carbon [10, 11, 12]. Three instances of the process were completed with an estimated average. The percentage of total ash was calculated using the formula below.

% (w/w) Total ash = $Fw - Pw / W \times 100$

Where, Fw = Final weight of crucible with total ash Pw = Pre-weight of crucible W = Total weight of powdered plant material.

Determination of water-soluble ash value

The ash obtained from total ash was boiled in 25ml of 2 M hydrochloric acid for 5 minutes. The insoluble materials were then collected by using the ash-less filter paper, further rinsed with hot water, ignited, cooled in a desiccator, and weighed. Using the following formula, the amount of acid-insoluble ash relative to the air-dried medication is calculated as:

% (w/w) Acid insoluble ash = $Fw - Pw / W \times 100$

Where, Fw = Weight of dish + Ash (After complete incineration) Pw = Weight of the empty dish W = Total ash

Determination of water-soluble ash value

The whole ash was heated for five minutes in 25 ml of water, and the insoluble material was then collected on ash less filter paper, cleaned with hot water, and ignited for 15 minutes at 450°C. By subtracting the weight of the insoluble portion from the total weight of ash, the weight of the soluble component was calculated:

% (w/w) Water soluble ash = $(X - Y) / X \times 100$

Where, X = Total ash Y= Water insoluble ash

Transverse section of plant

Preparation of section and staining Whole or quarter parts of fresh fruit were sectioned into thin circular slice by using thin slice was treated with diluted safranin and observed under microscope [13, 14].

Histological evaluation

The epicarp, mesocarp, and endocarp are three distinct zones that make up the pericarp.

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Epicarp

The cuticle is typically thick and smooth, but it can vary greatly. The epidermis is made up of densely packed, isodiametric cells. In the hypodermis region, one can see one to two layers of thick-walled sub rectangular collenchyma cells packed closely.

Mesocarp

There are nine to twelve juicy parenchymatous layers in the internal part of the mesocarp, each made up of spherical cells with thin walls and internal gaps. Crystals of calcium oxalate are present in some cells. Greater size exists between inner and outer cells. Just below the hypodermis, in the mesocarp's outer area, are sclereid cells.

Endocarp

Vascular bundles (scalariform) vessels are seen in this region.

Phytochemical screening [15, 16]

Test for Carbohydrate

Mayer's test

Mayer's reagent (Potassium mercuric iodide solution) was added to 3ml of extract results in the formation of a white or cream-colored precipitate was observed.

Wagner's test

To 3ml of filtrate, few drops of Iodine in Potassium Iodide (Wagner's Reagent) were added and observed, resulting in the formation of a red brown precipitate.

Molisch's test

Few drops of Molisch reagent was added to 3-4 ml of aqueous extract and shaken, to above solution concentrated H_2SO_4 was added from side of the test tube, a violet ring is formed at the junction of two liquids indicate the presence of carbohydrate.

Fehling's Test

1ml of Fehling's solution A and 1 ml of Fehling's solution B were mixed and boiled for one minute. To this, equal volume of test solution was added and boiled for 5- 10 minutes. Initially yellow then brick red precipitate is observed.

Tests for anthraquinone glycosides

Modified Borntrager's test

To 5 ml extract, add 5ml of 5% ferric chloride and 5ml of dilute HCL. Boil for 5 minutes then allow cooling. Add chloroform or any organic solvent. Shake continuously. Separate the organic layer and add an equal volume of diluted ammonia. The ammoniacal layer indicates pink red colour.

Test for flavonoids

Alkaline Reagent Test

3-4 ml of aqueous extract solution was added to a 10% ammonium hydroxide solution. Yellow colour is observed indicates the presence of flavonoid.

Test for tannins and phenols

Lead acetate solution

A few drops of lead acetate solution were added to 23mL of alcoholic extract, a white precipitate is seen.

Dilute Nitric acid

A few drops of dilute nitric acid was added to 3 ml of alcoholic extract, first reddish then yellow colour is observed.

In-vitro antioxidant activity

In-vitro antioxidant activity of the methanolic extract of *Lycopersicon pimpinellifolium* L   (fruit) was carried out by using DPPH, Ferric reducing and H_2O_2 assays.

DPPH antioxidant assay

3ml of plant extract or standard of different concentration solution (20μg/ml- 100μg/ml) was taken in a test tube and to this 1ml of 0.1mM DPPH solution is added [17, 18, 19]. After that test tube were incubated for 20 minutes at room temperature at dark place. The decrease in absorbance was measured at 517nm using a UV-VIS spectrophotometer. The percentage inhibition of ridiculous was calculated by using the following formula-

% inhibition= (**A**control−**A**sample) /**A**control ×100

Ferric reducing power assay

2ml of plant extract or standard of different concentration solution (20μg/ml -100 μg/ml) was taken in a test tube and to this 2ml of 0.2M phosphate buffer (PH 6.6) and 2ml of 1% Potassium ferricyanide solution is added [20, 21, 22]. The reaction mixture was vortexed well and incubated it for about 20 minutes at 50∘C. After that 2ml of 10% trichloroacetic acid was added to it and centrifuged at 3000rpm for 10 minutes. 2.5ml of supernatant fluid is mixed with 2.5ml distilled water and 0.5ml of 0.1% Ferric chloride. The absorbance of the mixture was measured at 700nm using a UV-VIS spectrophotometer. A blank was prepared without adding extract/ standard.

Hydrogen peroxide scavenging activity

0.4ml of plant extract or standard of different concentration solution (20μg/ml -100 μg/ml) was taken in a test tube and to this 2.4ml hydrogen peroxide (2mM) and 1.6ml Phosphate buffer (40mM) is added [23, 25] after that test tube were incubated for 10 minutes at room temperature. Absorbance of hydrogen peroxide was taken at 230 nm against a blank solution containing the phosphate buffer without hydrogen peroxide.

Total phenolic content

The total phenolic content of extract was determined by using Folin-Ciocalteu method. 0.5ml of crude extract (200μg/ml) was taken in a test tube and to this 2.5ml of 10% FCR reagent and 2.5ml of 7.5% Na_2CO_3 solution was added [26]. After that the test tube was incubated for 1 hour at 25∘C to complete the reaction. Then Absorbance of the solution was measured at 760nm using a UV spectrophotometer against blank consists of 5ml methanol, 2.5ml FCR reagent and 2.5ml Na_2CO_3. The total phenolic content was determined using a standard curve with gallic acid (20-100μg/ml). The total phenolic content was expressed in mg of gallic acid equivalents (GAE) / g of extract.

Total flavonoid content

1ml of plant extract (200μg/ml) was taken in a test tube and to this 0.1ml of 10% (w/v) AlCl3 and 0.1ml of 0.1mM potassium acetate solution and 2.8ml distilled water is added [26]. Then the mixer was kept at room temperature for about 30 minutes. The maximum absorbance of the solution mixture is measured at 415 nm in UV spectrophotometer against a blank sample containing 1 mL extract solution, 0.1ml of potassium acetate, 2.8 ml distilled water without $AlCl_3$. The total flavonoid content was determined using a standard curve with quercetin (20-100μg/ml). The Total flavonoid content was expressed as mg of quercetin equivalent (QE) /g of extract.

RESULTS AND DISCUSSION

Physicochemical evaluation of fruit extract of *Lycopersicon pimpinellifolium* L was analysed and represented in Table 1. Transverse section of *Lycopersicon pimpinellifolium* L (Fruit) showed presence of Epidermis, Epicarp, Mesocarp, Endocarp, Parenchyma; Trichomes ,Septa,Placenta,Outer pericarp, Mesophyll tissue (Figure 1). The preliminary phytochemical studies show the presence of Carbohydrate, Flavonoids Tannins, saponins and Phenols (Table 2). The presence of chemical components demonstrates that the plant may have valuable medical characteristics. The calibration curve (y = 0.0137x - 0.0105; R² = 0.9867) obtained from the gallic acid concentrations and expressed in mg of gallic acid equivalence (GAE) per gram was used to calculate the TPC of the extracts (Figure 7). A regression model was used to calculate the amount of phenolic compounds present in extract and value was found to be 19.86mg of gallic acid equivalent/g of phenols. The calibration curve (y = 0.0097x - 0.0072; R² = 0.9971) obtained from the quercetin concentrations and expressed in mg of quercetin equivalence (QUE) per gram was used to calculate the

TFC of the extracts (Figure 8). A regression model was used to calculate the amount of flavonoid compounds present in extract and amount was found to be 21.25mg of quercetin equivalent/g of flavonoid. In this method BHT is used as a standard. Figure 9 demonstrated that 100μg/ml concentration of extract showed highest antioxidant activity which is 42.38% inhibition whereas the BHT at 20μg/ml concentration showed 62.98% inhibition. The strong scavenging activity of the extract of fruit *Lycopersicon pimpinellifolium* L on DPPH was possibly due to the hydrogen donating ability of the poly phenolic compound present in the extract. Reducing power assay method is based on the principle that substances, which have reduction potential, react with potassium ferricyanide (Fe^{3+}) to form potassium ferrocyanide (Fe^{2+}), which subsequently combine with ferric chloride to form ferric-ferrous complex, which has an absorption maximum at 700 nm. With an increase in sample and standard concentration, the reduction power of the extracts and standard also increases (Figure 10, 11). The scavenging ability of fruit extracts of *Lycopersicon pimpinellifolium* L on H_2O_2 shown in Figure 12. The principle of this activity is absorbance of Hydrogen peroxide is decrease upon oxidation by phytocompounds. In this method BHT is used as a standard. The 80μg/ml concentration of extract showed highest antioxidant activity which is 15.65% inhibition, whereas the BHT at 20μg/ml concentration showed 11.88 % inhibition. IC_{50} value for the extract and BHT was found to be 69.65 and 242.20 respectively.

CONCLUSION

From the result of preliminary phytochemical study, it can be concluded that the crude extract of fruit consists of carbohydrates, alkaloids, flavonoids, tannins, saponins and phenols and this indicates that the plant may have valuable medicinal characteristics. The methanolic extract of *Lycopersicon pimpinellifolium* L (fruit) has shown considerable amount of antioxidant activity that may help in the treatment of various diseases.

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Table 1: Physico chemical Evaluation of Powder of *Lycopersicon pimpinellifolium* **L**

Sl. No.	Characterstics	Observation	Test Method
1	Appearance	Fine Powder	Visual
2	Colour	Red	Visual
3	Odour	Sour	Organoleptic
4	Taste	Sour	Organoleptic
5	Fracture	Smooth	Visual
6	Total Ash value	11.5	I.P 1996
7	Acid insoluble Ash	1	I.P 1996
8	Water insoluble ash	2	I.P 1996

Table 2: Data for phyto chemical screening

Tests	Result	
Carbohydrates	Molisch's Test	+
	Fehling's Test	+
	Benedict's Test	+
	Barfoed's Test	+
Alkaloids	Dragendroff's Test	-
	Hager's Test	-
	Mayer's Test	-
	Wagner's Test	-
Cardiac Glycosides	Legal's Test	-
	Keller-Killiani Test	-
Anthraquinone Glycosides	Borntrager's Test	-
	Modified Borntrager's Test	
Saponin Glycosides	Foam Test	+
Flavonoids	Sulphuric Acid Test	+
	Alkaline Reagent Test	+
Tannins And Phenols	Lead Acetate Solution	+
	5% Ferric Chloride Solution	-
	Dilute Nitric Acid	+
Steroid	Salkowski Test	-

Figure 1: *Lycopersicon pimpinellifolium* L	**Figure 2: Shade drying**
Figure 3: Powder	**Figure 4: Filtration of extract**
Figure 5: Extract of *Lycopersicon pimpinellifolium* L	**Figure 6: Transverse section of** *Lycopersicon pimpinellifolium* L **(Whole fruit)**
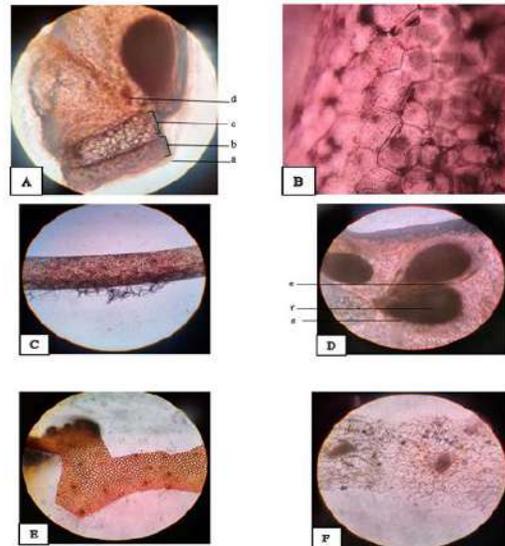
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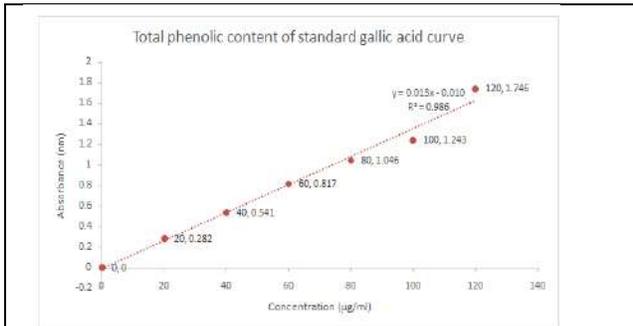
Figure 7: Gallic acid calibration curve
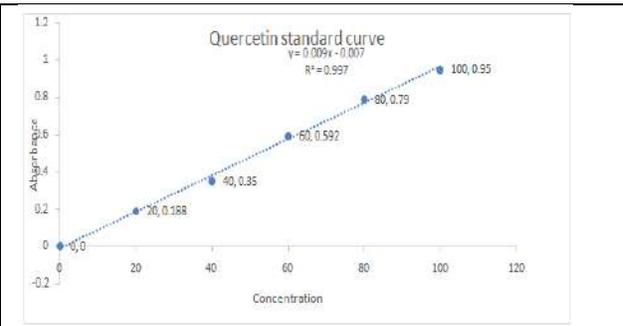
Figure 8: Quercetin calibration curve
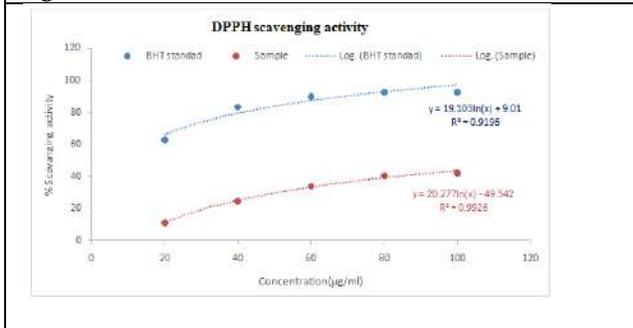
Figure 9: DPPH Scavenging activity of methanolic extract and Standard BHT
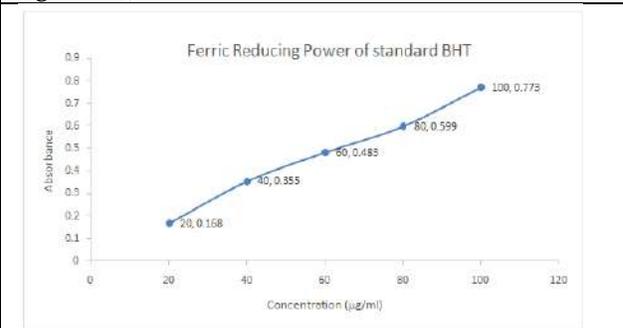
Figure 10: Reducing power of standard BHT
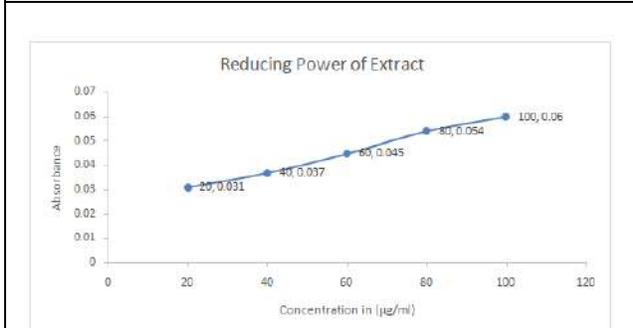
Figure 11: Reducing power of extract of *Lycopersicon pimpinellifolium* L
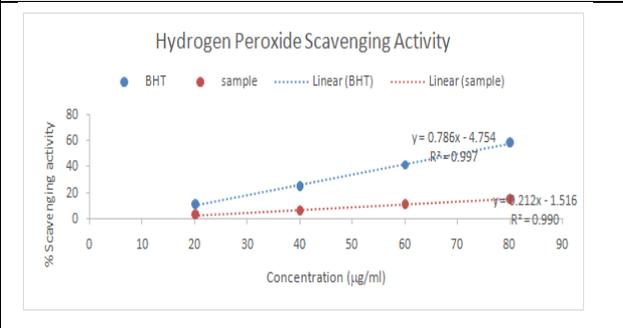
Figure 12: H₂O₂ Scavenging activity of Extracts and Standard BHT

RESEARCH ARTICLE

On Beta Generalized I - Closed Sets in Ideal Topological Spaces

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ABSTRACT

In this paper, we introduce the new concept of closed sets called Beta generalized I- closed sets in ideal topological spaces are defined and some of their properties are discussed with few examples. Also we introduce the concept of Beta generalized I- continuity in ideal topological spaces and discussed their properties.

Keywords: Closed set, Open set, βg-closed set, β-open set, βgI-closed set, βgI-continuous set.

INTRODUCTION

In 2022, Kavitha and Sasikala[1] introduced beta generalized closed sets. Levine[9] generalized closed sets in topology. Levine(1960) introduced and studied the concepts of semi-open sets in topological spaces and investigated semi-open sets, semi generalized open sets, generalized open sets, semi-open sets, pre-open sets and alpha-open sets which are some of the weak forms of open sets and the complements of these sets are called closed sets of the same type. In the year 1999, Dontchev proved that a mapping f: $(X,\tau,I) \rightarrow (Y,\sigma)$ is continuous if and only if it is pre-I-continuous, which is an idealized version of gensterreilly decomposition theorem.

An ideal I is an nonempty collection of subsets of X closed with respect to finite union. (X,τ, I) is an ideal topological space and it is called as an ideal space. For a subset A of X, the local function of A is defined as: $A^* = \{x \in X: U \cap A \notin I$ for every $U \in \tau(x)$, where $\tau(x)$ is the collection of all nonempty open sets containing x. From this simply write A^* instead of $A^*(I)$ to avoid any chance of confusion. A Kuratowski closure operator $cl^*(.)$ for a topology $\tau^*(I,\tau)$ termed

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as *-topology, finer than τ is determine cl*(A) = A ∪ A*. If A contained in X, cl(A) and int(A) will denote the closure and interior of A in (X, τ) respectively and cl*(A) and int*(A) will denote the closure and interior of A in (X, *τ) respectively.

PRELIMINARIES

Throughout this paper (X,τ) represent topological spaces. For a subset A of a space (X,τ), cl(A), int(A) denote the closure of A and the interior of A respectively. We recall the following definitions.

Definition 2.1 Let (X,τ) be a topological space. Let I be an ideal defined on X. Then the space (X,τ,I) is termed as ideal topological space, which satisfies the following two conditions:
1. If A ∈ I and B ⊆ A⟹B ∈ I.
2. If A ∈ I and B ∈ I, then A∪ B∈ I.

Definition 2.2 A subset A of a topological space X is said to be
1. a generalized closed (g-closed) set if cl(A)⊆ U whenever A is a subset of U and U is open in the space X.
2. a semi generalized closed (sg-closed) set if scl(A) ⊆ U whenever A is a subset of U and U is semi open in the space X.
3. a generalized semi closed (gs-closed) set if scl(A) ⊆ U whenever A is a subset of U and U is open in the space X.
4. an α generalized closed (αg-closed) set if αcl(A) ⊆ U whenever A is a subset of U and U is open in the space X.
5. an generalized α closed (gα-closed) set if αcl(A) ⊆ U whenever A is a subset of U and U is α-open in the space X.
6. a generalized semi-pre-closed (gsp-closed) set if spcl(A) ⊆ U whenever A is a subset of U and U is open in the space X.
7. a generalized pre-closed (gp-closed) set if pcl(A) ⊆ U whenever A is a subset of U and U is open in the space X.
8. a regular generalized closed (rg-closed) set if cl(A) ⊆ U whenever A is a subset of U and U is regular open in the space X.
9. a generalized preregular-closed (gpr-closed) set if pcl(A) ⊆ U whenever A is a subset of U and U is regular open in the space X.
10. a weakly closed (w-closed) set if cl(A) ⊆ U whenever A is a subset of U and U is semi-open in the space X.
11. a weakly generalized (wg-closed) set if cl(int(A)) ⊆ U whenever A is a subset of U and U is open in the space X.
12. a strongly g-closed (g*-closed) set if cl(A) ⊆ U whenever A is a subset of U and U is g-open in the space X.
13. a generalized star pre-closed (g*p-closed) set if pcl(A) ⊆ U whenever A is a subset of U and U is g-open in the space X.
14. a regular weakly generalized (rwg-closed) set if cl(int(A)) ⊆ U whenever A is a subset of U and U is regular-open in the space X.
15. a g$^{\#}$-closed set if cl(A) ⊆ U whenever A is a subset of U and U is αg-open in the space X.

Definition 2.3
A subset A of an Ideal topological space (X,τ,I) is termed as
1. pre-I-closed set if cl*(int(A)) ⊆ A. If A ⊆ (int(cl*(A)) then A is called as pre-I-open set.
2. semi-I-closed set if int(cl*(A)) ⊆ A. If A ⊆ (cl*(int(A)) then A is called as semi-I-open set.
3. α-I-closed set if cl*(int(cl*(A))) ⊆ A. If A ⊆ (int(cl*(int(A))) then A is called as α-I-open set.
4. β-I-closed set if (int(cl*(int(A))) ⊆ A. If A ⊆ (cl*(int(cl*(A))) then A is called as   β-I-open set.
5. regular-I-closed set if A = cl*(int(A)). If A = (int(cl*(A)) then A is called as   regular-I-open set.

Definition 2.4 A function f : (X,τ) →(Y, σ) is said to be
1. a g-continuous if f⁻¹(Z) is g-closed in the space X for every closed set Z of (Y,σ).
2. a gpr-continuous if f⁻¹(Z) is gpr-closed in the space X for every closed set Z of(Y,σ).
3. a g*- continuous if f⁻¹(Z) is g*-closed in the space X for every closed set Z of (Y,σ).
4. a g- continuous if f⁻¹(Z) is g-closed in the space X for every closed set Z of (Y,σ).
5. a g$^{\#}$- continuous if f⁻¹(Z) is g$^{\#}$-closed in the space X for every closed set Z of (Y,σ).

Lemma 2.5 Let A, B be subsets of X. Let (X, τ, I) be an Ideal topological space. Then the following properties are:

1. $A \subseteq B \Longrightarrow A^* \subseteq B^*$,
2. $A^* = cl(A^*) = cl(A) = cl^*(A)$,
3. $(A \cup B)^* = A^* \cup B^*$,
4. $(A \cap B)^* \subseteq A^* \cap B^*$,
5. $(A^*)^* \subseteq A^*$.

βgI - Closed Sets in Ideal Topological Spaces

Definition 3.1 A subset B of an ideal topological spaces(X, τ , I) is called an beta generalized ideal (βgI) - closed set, if $B^* \subseteq D$ whenever B is a subset of D ($B \subseteq D$) and D is g-open in ideal topological space (X, τ, I). The complement of an βgI - open set is βgI - closed set in ideal topological space.

Example 3.2 Let X = {u, v, w}, I = {ϕ, {v}} and τ = {ϕ, {v}, {v, w}, X}. The βgI closed sets of X are {ϕ, {u}, {v}, {u, v}, {u, w}, X}.

Theorem 3.3 Every βg-closed set in the ideal topological space (X, τ, I) is an βgI - closed set. **Proof:** Let B be a βg-closed set in the ideal topological space (X, τ, I). Let D be any g-open set in X such that $B^* \subseteq D$. Since every g-open set is $B^* \subseteq cl(B) \subseteq D$. Now, $B^* \subseteq cl^*(B) \subseteq cl(B) \subseteq D$. This shows that B is an βgI- closed set in ideal topological space. Henceforth every βg-closed set in ideal topological space is a βgI - closed set. In general, the converse of this theorem does not hold.

Example 3.4 Let X = {u, v, w}, I = {ϕ, {v}} and τ = {ϕ, {v}, {v,w}, X}. The βgI closed sets of X are {ϕ, {u}, {v}, {u, v}, {u,w}, X}. Here B = {v} is βgI - closed set but it is not a βgI -closed set.

Theorem 3.5 Every g#-closed set in the ideal topological space (X, τ, I)is an βgI - closed set.
Proof: Let B be a g#-closed set in the space (X, τ, I). Let D be any g-open set in X such that $B^* \subseteq D$. Since every g-open set is αg-open, $B^* \subseteq cl(B) \subseteq D$. Now, $B^* \subseteq cl^*(B) \subseteq cl(B) \subseteq D$. This shows that B is an βgI - closed in ideal topological space. Henceforth every g#-closed set in ideal topological space is anβgI - closed set. In general, the converse of this theorem does not hold.

Example 3.6 Let X = {u, v, w}, I = {ϕ, {u}} and τ = (ϕ, {u, v}, X}. The βgI - closed sets of X are {ϕ, {u}, {w}, {v, w}, {u, w}, X}. Here B = {u} is βgI - closed set but it is not a g#-closed set.

Theorem 3.7 Every r - closed, α - closed, β - closed, pre - closed, g*- closed, α g - closed,   g α - closed, wg - closed, sg - closed, gs - closed sets in the space is βgI - closed set in the ideal topological space (X, τ, I).

Proof: It follows from that, every open set is g-open set in the space (X, τ, I). In general the converse of this theorem does not hold. This is shown in the following example.

Example 3.8
1. Let X = {u, v, w}, I = {ϕ, {w}} and τ = {ϕ, {v}, {w}, {v, w}, {u, v}, X}. The βgI closed sets of X are {ϕ, {u}, {w}, {u, v}, X}. Here B = {u} is βgI - closed set but it is not a r - closed set.
2. Let X = {u, v, w}, I = {ϕ, {u}} and τ = {ϕ, {v}, {u, v}, X}. The βgI closed sets of X are {ϕ, {u}, {w}, {v, w}, {u, w}, X}. Here B = {v, w} is βgI - closed set but it is not a α - closed and β - closed set.
3. Let X = {u, v, w}, I = {ϕ, {v}} and τ = {ϕ, {u}, {v}, {u, v}, X}. The βgI closed sets of X are {ϕ, {v}, {w}, {v, w}, {u, w}, X}. Here B = {v} is βgI - closed set but it is not a pre-closed set.
4. Let X = {u, v, w}, I = {ϕ, {w}} and τ = {ϕ, {u}, {v, w}, X}. The βgI closed sets of X are {ϕ, {u}, {w}, {v, w}, X}. Here B = {w} is βgI - closed set but it is not a g*-closed set.

5. Let X = {u, v, w}, I = {ϕ, {u}} and τ = {ϕ, {u, v}, X}. The βgI closed sets of X are {ϕ, {u}, {w}, {v, w}, {u, w}, X}. Here B = {u} is βgI - closed set but it is not a α g and g α-closed set.

6. Let X = {u, v, w}, I = {ϕ, {u}} and τ = {ϕ, {u}, {w}, {u, v}, {u, w}, X}. The βgI closed sets of X are {ϕ, {u}, {v}, {w}, {u, v}, {v, w}, X}. Here B = {v, w} is βgI-closed set but it is not a wg -closed set.

7. Let X = {u, v, w}, I = {ϕ, {v}} and τ = {ϕ, {v}, {v, w}, X}. The βgI closed sets of X are {ϕ, {u}, {v}, {u, v}, {u, w}, X}. Here B = {v} is βgI - closed set but it is not a sg and gs - closed set.

Theorem 3.9 The class of βgI - closed set in the ideal topological space (X, τ, I) is independent of the class of rwg - closed, rg - closed, gp - closed, gpr - closed, g*p - closed and gsp - closed sets in the space (X, τ, I).

Proof: It follows from that, every open set is g-open set in the space (X, τ, I). In general the converse of this theorem does not hold.

Example 3.10
1. Let X = {u, v, w}, I = {ϕ, {v}} and τ = {ϕ, {u}, X}. The βgI closed sets of X are {ϕ, {v}, {v, w}, X}. Here B = {u} is rwg - closed set but it is not a βgI - closed set.

2. Let X = {u, v, w}, I = {ϕ, {w}} and τ = {ϕ, {w}, {u, w}, X}. The βgI closed sets of X are {ϕ, {v}, {w}, {u, v},{v, w}, X}. Here B = {u, w} is rg – closed set but it is not a βgI - closed set.

3. Let X = {u,v,w}, I = {ϕ, {v}} and τ = {ϕ, {w}, {u, v}, X}. The βgI closed sets of X are {ϕ, {v}, {w}, {u, v}, X}. Here B = {u, w} is gp - closed set but it is not a βgI -closed set.

4. Let X = {u, v, w}, I = {ϕ, {w}} and τ = {ϕ, {v}, {w}, {v, w}, X}. The βgI closed sets of X are {ϕ, {u}, {w}, {u, v}, {u, w}, X}. Here B = {v, w} is gpr - closed set but it is not a βgI - closed set.

5. Let X = {u, v, w}, I = {ϕ, {v}} and τ = {ϕ, {u}, X}. The βgI closed sets of X are {ϕ, {v}, {v, w}, X}. Here B = {w} is g*p - closed set but it is not a βgI - closed set.

6. Let X = {u, v, w}, I = {ϕ, {v}} and τ = {ϕ, {u}, {v}, {u, v}, X}. The βgI closed sets of X are {ϕ, {v}, {w}, {v, w}, {u, w}, X}. Here B = {u} is gsp - closed set but it is not a βgI - closed set.

Theorem 3.11 Union of two βgI - closed sets are βgI - closed set in any ideal topological space (X, τ, I).

Proof: Let M and N be two βgI - closed sets in the ideal topological space. Let D be any g-open set in X such that M ∪ N ⊆ D. Then, M ⊆ D and N ⊆ D, M and N are βgI - closed sets. Since M* ⊆ D and N* ⊆ D whenever M* ∪ N* ⊆ (M ∪N)*⊆ D, D is g-open. Henceforth M ∪ N is βgI - closed set in ideal topological space.

Remark 3.12 The intersection of two βgI - closed sets need not be a βgI - closed set.

Theorem 3.13 For an element x ∈ X, then the set X - x is a βgI - closed set (or) g-open set.
Proof: Let x ∈ X suppose that X - x not g-open set. Then X is the only g-open set containing X - x. This implies that B*(X - x) ⊆ X. Hence X - x is βgI - closed set in X.

Theorem 3.14 If B is both open set and g-closed set in X, then B is βgI - closed set in X.

Proof: Let B ⊆ D and D be g-open set in X. Now B ⊆ B, by hypothesis αcl(B) ⊆ B. Since every closed set is a β - closed set, βcl(B) ⊆ cl(B). Thus βcl(B) ⊆ B ⊆ D. Hence B is βgI - closed set in X.

Theorem 3.15 A subset B is βgI - open in the ideal topological space (X, τ, I) iff E ⊆ int*(B) whenever E is g-closed set and E ⊆ B.

Proof: Suppose that B is βgI - open set in the ideal topological space (X, τ, I). Let E ⊆ B and E be a g-closed set. Then X - B ⊆ X - E and X - E is g-open. Since X - B is βgI - closed, then (X - B)*⊆ X - E and X - int*(B) = cl*(X - B) = (X - B) ∪ (X - B)* ⊆ X - E and henceforth E ⊆ int*(B). Conversely, let X - B ⊆ D where D is g-open. Then X - D ⊆ B and X - D is

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g-closed. By hypothesis, we have X - D ⊆ int*(B) and henceforth (X - B)*⊆ cl*(X - B) = X -int*(B) ⊆ D. X - B is βgI - closed set and B is βgI - open.

Theorem 3.16 Let B be a βgI - closed set in (X, τ, I). Then B is β - closed set if and only if B*- B is g-closed set.
Proof: Suppose B is a βgI - closed set in X. Then B* = B and B*- B = ϕ which is a g-closed set in X. Conversely, supposed B*- B is g-closed set in X. Since B is βgI - closed set, B*- B does not contain any non-empty g-closed set in X. That is B*- B = ϕ. Henceforth B is β -closed.

Theorem 3.17 If B is βgI - closed in (X, τ, I) and if B ⊆ C ⊆ B* then C is also βgI - closed set in (X, τ, I).
Proof: Let D be an g-open set of (X, τ, I) such that C ⊆ D. Since B ⊆ D and B is βgI - closed set, B* ⊆ D. Since C ⊆ B*, C* ⊆ B* = B*. Thus C* ⊆ D. Henceforth C is a βgI - closed set of (X, τ,I).

βgI - Continuity in Ideal Topological Spaces
Definition 4.1 A function h : (X, τ, I) → (Y, σ) is called a βgI - continuous if $h^{-1}(z)$ is βgI -closed set of the space (X, τ, I) for every closed set z of (Y, σ).

Theorem 4.2 Every continuous map in the ideal topological space (X, τ, I) is βgI - continuous.
Proof: Let h be a continuous and let z be a closed set of (Y, σ). Since h is continuous, then $h^{-1}(z)$ is closed in the space (X, τ, I). But every closed set in ideal topological space is βgI -closed set. Henceforth $h^{-1}(z)$ is βgI - closed set in ideal topological space (X, τ, I). Thus h is an βgI - continuous in the ideal topological space. In general the converse of this theorem does not hold. It is shown in the following example.

Example 4.3 Let X = {u, v, w}, τ = {ϕ, {v}, {v, w}, X} and Y = {u, v, w}, σ = {ϕ, {u, w}, {u}, X} and I = {ϕ, {v}}. Let h : (X, τ, I) → (Y, σ) be the identity function defined by h(u) = u, h(v) = v, h(w) = w. Therefore Z is a βgI - continuous but it is not a continuous.

Theorem 4.4 Every g-continuous function is βgI - continuous.
Proof: Let h be a continuous function and let z be a closed set of (Y, σ) then $h^{-1}(z)$ is g-closed set in (X, τ, I). Since every g-closed set is βgI - closed set, $h^{-1}(z)$ is βgI - closed set in the space (X, τ, I).Therefore h is βgI - continuous.

Example 4.5 Let X = {u, v, w}, τ = {ϕ, {v}, {w}, {v, w}, X} and Y = {u, v, w}, σ = {ϕ, {w}, X} and I = {ϕ, {v}}. Let the function h : (X, τ, I) → (Y, σ) be the identity function. Then the function h is βgI - continuous but it is not a g-continuous.

Theorem 4.6 Every g#- continuous function is βgI - continuous.
Proof: Let h be an continuous function and let z be a closed set of (Y, σ) then $h^{-1}(z)$ is g# -closed set in (X, τ, I). Since every g#- closed is βgI - closed set. Henceforth $h^{-1}(z)$ is a βgI -closed set in the space (X, τ, I). Therefore h is a βgI - continuous.

Example 4.7 Let X = {u, v, w}, τ = {ϕ, {v}, {w}, {v, w}, X} and Y= {u, v, w}, σ = {ϕ, {w}, X} and I= {ϕ, {v}}. Let the function h : (X, τ, I) → (Y, σ) be the identity function. Then the function h is a βgI - continuous but it is not a g# - continuous.

Theorem 4.8 A map h : (X, τ, I) → (Y, σ) is βgI - continuous if and only if the inverse image of every closed set in (Y, σ) is βgI - closed in (X, τ, I).
Proof: Necessary: Let z be a closed set in (Y, σ). Since h is βgI - continuous, $h^{-1}(z^c)$ is βgI -closed in (X, τ, I). But $h^{-1}(z^c)$ = X – $h^{-1}(z)$. Henceforth $h^{-1}(z)$ is βgI - closed in (X, τ, I).
Sufficiency: Assume that the inverse image of every closed set in (Y, σ) is βgI - closed in (X, τ, I). Let z be a closed set in (Y, σ). By our assumption $h^{-1}(z^c)$ = X – $h^{-1}(z)$ is βgI - closed in (X, τ, I)which implies that $h^{-1}(z)$ is βgI - closed in the space (X, τ, I). Henceforth his βgI -continuous.

CONCLUSION

In this paper an attempt was made to study about the new class of generalized closed sets via ideal topological spaces. This paper focuses on βgI - closed sets in ideal topological spaces and also some of their properties were discussed. The continuity of βgI - function was also defined and its properties were discussed.

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RESEARCH ARTICLE

In vitro Antimicrobial Activity of *Tephrosia pulcherrima* Root Extracts against Human Pathogenic Bacteria

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ABSTRACT

The objective of this study was to evaluate the positive antimicrobial properties of ethanol extract of *Tephrosia pulcherrima.* The extracts were investigated individually for in vitro antibacterial activity by cup plate (well diffusion) method against five pathogenic bacteria. It was observed that ethanolic extract (50 mg/well) was the most potential antimicrobial activity against all tested bacteria strains with zone of inhibition between 11 to 18mm. However their antimicrobial effects were found to be less potent than the reference antibiotics. Under crude Ethanol extract against *E.coli* shows (18mm), *Streptococcus* shows (18mm), *Staphylococcus aureus* shows (15mm), *Pseudomonas aerginosa* shows (16mm) and *Salmonella* shows (15mm) their respective inhibition under Crude Ethanol extract. They are more then antimicrobial principle of the plant extract inhibited the growth of both the bacterial test organisms employed in the study, as evidenced from the clear zones formed around the disc. The antibacterial activities of the investigated plants could make it useful in microbial infections.

Keywords: *Tephrosia pulcherrima* stem extract, Antimicrobial activity.

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INTRODUCTION

The extensive use of antibiotics in clinical medicine, veterinary medicine, and agriculture all contribute to the development of antibiotic resistance in pathogenic microbial strains, which ultimately represents a very severe challenge in the management of pathogenic bacteria (Kapil, 2005). This has prompted researchers to look for new antimicrobial agents, mostly in plant extracts, in an effort to identify novel chemical structures that might address the aforementioned drawbacks (Lewis, 2006). Numerous studies that attempt to understand the various antimicrobial components of medicinal plants and use them for the treatment of microbial diseases as potential substitutes for synthetic medications to which many pathogenic bacteria have developed resistance have been documented. In addition to being a significant source of novel antimicrobial medicines, plants have long been utilized to treat infectious disorders. The antimicrobial benefits of herbal plant extracts, including roots, stems, leaves, or flowers, have been the subject of several studies (Abu-Shanab, 2005). In order to verify the antibacterial activity of plants used in traditional medicine and explore the possibility of include them in basic healthcare, several nations in Africa and other regions of the world have continued to support screening initiatives. (Baker,1978). The oldest and still the most important source of new and potent medications are medicinal plants. The capacity to use active plant chemicals or their synthetic equivalents in medicine has improved with the development of phyto chemistry and pharmaceutical chemistry. This is mostly due to the fact that medicinal plants have a greater degree of chemical variety and originality than any other sources (Harvey, 2001; Chin et al., 2006).

Several studies have shown that plant extracts have antibacterial action against microorganisms that cause food poisoning (Duine et al., 2005; Alzoreky and Nakahara, 2003; Verma et al., 2012; Akinpelu et al., 2015). (Gupta et al., 2010) investigated antibacterial activity of five ethanolic and aqueous plant extracts against S. aureus, Pseudomonas aeruginosa and Bacillus subtilis and their results showed that the ethanolic extracts of four plants (Achyranthes as per a, *Cynodon dacynodon dactylon, Lantana camara* and *Tagetes patula*) were effective against all tested microorganisms with MIC's ranged from 25 to 125 mg/ml. According to (Saldaha,1984) investigation on the antibacterial effects of guava leaves, garlic, and ginger against a variety of human microbes, ginger was only effective against S. aureus whereas guava and garlic were effective against all tested microorganisms. (Akinpelu et al., 2015) According to several studies, ethanolic clove extract was ineffective against *E. coli* and Salmonella enteritidis but showed potential activity against *S. aureus, Vibrio parahaemolyticus,* and *P. aeruginosa* (Mahfuzul Hoque et al., 2007). *While Vibrio cholera, S. typhi, and Klebsiella pneumonia* were shown to be resistant to aqueous clove extract, other researches confirmed the efficacy of clove oil against all tested harmful bacteria (Singleton, 1999).; Saeed et al., 2013). Additionally, a MIC range of 0.1 to 2.31 mg/ml for the methanolic clove extract was shown to be possibly effective against *S. aureus, P. aeruginosa,* and *E. coli* (Pandey and Singh, 2011).

In accordance to many studies (Ansari and Ali.,1996; Shan et al., 2007; Chaudry and Tariq, 2008), the antimicrobial activity of cumin seeds (*Cuminum cyminum*) extract may be effective against a number of types of Gram positive and Gram negative bacteria linked to food poisoning with varying MICs. The potential antibacterial properties of the selected Thai medicinal herbs were examined using two distinct bacterial strains. While Escherichia coli, a Gram negative bacillus, causes serious infectious diseases like urinary tract infections and bloodstream infections, *Staphylococcus aureus* is one of the most prevalent Gram positive bacteria that causes common infectious diseases like soft tissue infection and community associated bloodstream infection (Pandey., 2011). The Leguminosae family's Tephrosia genus has more than 350 species, many of which have significant traditional medicinal benefits for the treatment of several ailments. Tephrosia is a large pantropical genus. The Indian subcontinent is home to wild indigo, purple tephrosia, and fish poison. This genus' plants are extensively dispersed in various tropical and subtropical nations throughout the world. This study also gives an overview of various pharmacological activities like antioxidant, antimicrobial, anticancer, antiplasmodial, anti-inflammatory, larvicidal and toxicity studies of extracts and fractions.

MATERIALS AND METHODS

Plant materials

Fresh, healthy and mature plant of *Tephrosia pulcherrima.* were collected from Pachaimallai Hills and authenticated by Dr. Soosairaj at Department of Botany St. Joseph's College Trichy, Tamil Nadu, India.

Extraction

Dried and coarsely powdered plant materials, (25 gm of each sample) were individually extracted in muslin bags with various solvents such as methanol by using continuous hot extraction with Soxhlet extractor, for 18 hrs. The crude extracts obtained were filtered through What man paper no .1 and the filtrates were evaporated under reduced pressure and low temperature to give a gummy solid residue. The dried extracts were weighed and stored in labelled sterile screw capped bottles in refrigerator.

Culture media

Antibiotics are one of our most important weapons in fighting bacterial infections and have greatly benefited the health-related quality of human life since their introduction. However, over the past few decades, these health benefits are under threat as many commonly used antibiotics have become less and less effective against certain illnesses not, only because many of them produce toxic reactions, but also due to emergence of drug-resistant bacteria. It is essential to investigate newer drugs with lesser resistance. Drugs derived from natural sources play a significant role in the prevention and treatment of human diseases. In many developing countries, traditional medicine is one of the primary healthcare systems. Herbs are widely exploited in the traditional medicine and their curative potentials are well documented. About 61% of new drugs developed between 1981 and 2002 were based on natural products and they have been very successful, especially in the areas of infectious disease and cancer. Recent trends, however, show that the discovery rate of active novel chemical entities is declining. Natural products of higher plants may give a new source of antimicrobial agents with possibly novel mechanisms of action.

Final pH 7.3 ± 0.1 at 25ºC

Mueller and Hinton developed Mueller Hinton Agar (MHA) in 1941 for the isolation of pathogenic Neisseria species. Nowadays, it is more commonly used for the routine susceptibility testing of non-fastidious microorganism by the Kirby-Bauer disk diffusion technique. Mueller Hinton Media contains Beef Extract, Acid Hydrolysate of Casein, Starch and Agar. Beef Extract and Acid Hydrolysate of Casein provide nitrogen, vitamins, carbon, amino acids, sulphur and other essential nutrients. Starch is added to absorb any toxic metabolites produced. Starch hydrolysis yields dextrose, which serves as a source of energy. Agar is the solidifying agent. Suspend 38 gm of the medium in one liter of distilled water. Heat with frequent agitation and boil for one minute to completely dissolve the medium. Autoclave at 121°C for 15 minutes. Cool to room temperature. Pour cooled Mueller Hinton Agar into sterile petri dishes on a level, horizontal surface to give uniform depth. Allow to cool to room temperature. Check for the final pH 7.3 ± 0.1 at 25ºC. Store the plates at 2-8 ºC.

Inoculum Preparation

From a pure bacterial culture (not more than 48 hours, old except for slow growing organisms), take four or five colonies with a wire loop. Transfer colonies to 5 ml of Trypti case soy broth or 0.9% saline. Incubate the broth at 30°C or at an optimum growth temperature until it achieves or exceeds the turbidity of 0.5 Mac Farland standard (prepared by adding 0.5 ml of 0.048 M $BaCl_2$ to 99.5 ml of 0.36 NH_2SO_4; commercially available). Compare the turbidity of the test bacterial suspension with that of 0.5 MacFarl and (vigorously shaken before use) against a white background with contrasting black line under adequate light. Arrow points to tube with correct turbidity. Reduce turbidity by adding sterile saline or broth.

Inoculation of plates

Dip a sterile cotton swab into the standardized bacterial suspension. Remove excess inoculum by lightly pressing the swab against the tube wall at a level above that of the liquid. Inoculate the agar by streaking with the swab containing the inoculum. Rotate the plate by 60° and repeat the rubbing procedure. Repeat two times. This will ensure and even distribution of the inoculum. Allow the surface of the medium to dry for 3-5 minutes but not longer than 15 minutes to allow for absorption of excess moisture.

Antimicrobial disks

The number of antimicrobial agents to be tested should be limited. To make the test practical and relevant, include only one representative of each group of related drugs; those indicated for veterinary use to control or prevent disease, and those that can be useful for epidemiological or research purposes. Use antibiotic disks purchased from a reputable manufacturer. The disk diameter is approximately 6 mm. Disks should be properly stored in a tightly sealed container with desiccant at 2-8°C. Expired disks should not be used. Using sterile forceps or disk dispenser, place antibiotic disk on the surface of the inoculated and dried plate. Immediately press it down lightly with the instrument to ensure complete contact between the disk and the agar surface. Do not move a disk once it has come into contact with the agar surface since some diffusion of the drug occurs instantaneously.

Incubation

Incubate plates in an inverted position at 30°C or at an optimum growth temperature. Observe for the zone of inhibition after 16 to 18 hours. Slow growing organisms may require longer incubation period.

Zones of Inhibition

The zone of inhibition is the point at which no growth is visible to the unaided eye. Read and record the diameter of the zones of inhibition using a ruler graduated to 0.5 mm. Round up the zone measurement to the nearest millimeter. The antibacterial activity against gram- negative bacteria (klebesiella pneumonia, Echerichia coli, pseudomonas aureus) gram- positive bacteria (Staphylococcus aureus, Bacillus thuringiensis).The effect of extract shows more effective antimicrobial activity.

RESULT AND DISCUSSION

Antimicrobial activity of *Tephrosia pulcherrima* extracts

In the present study, the antibacterial activity of *Tephrosia pulcherrima* was evaluated against *E. coli, S. aureus, P. aeruginosa* and *Salmonella* sp, ethanol, solvents were used for getting fractions of *Tephrosia pulcherrima*. A microorganism that has the ability to cause disease is called pathogen. There are a wide range of microorganisms that can cause severe harm to the body become lethal infectious disease still remains the topmost cause of death in world. The discovery of antibiotics has long been regarded as one of the most significant medical achievements of the twentieth century. Antibiotics have saved millions of lives and enabled important medical procedures, including surgery and cancer chemotherapy. The emergence and spread of antibacterial resistance in all geographical areas, including in bacteria that cause hospital- and community acquired infections, is, however, jeopardizing the effectiveness of these potentially lifesaving treatments. The threat includes the spread of multidrug-resistant bacteria, and infections with no therapeutic options have been reported. (Unemo et al, 2012). The antibacterial activity of *Tephrosia pulcherrima* extract on Escherichia coli was given in table 1 and shown in plate:1. Different concentrations of ethanol extract of *Tephrosia pulcherrima* showed high antibacterial activity against E. coli. However, the 30µ showed high antibacterial activity on *E. coli, S. aureus, P. aeruginosa* and *Salmonella* sp, with a mean zone of inhibition of 18 mm. The ethanol extract of *Tephrosia pulcherrima* showed the high antibacterial activity against the bacterial strain *E. coli, S. aureus, P. aeruginosa* and Salmonella sp, Results obtained in the current investigation revealed that studied herbal extracts possess potential antibacterial activity against *B. cereus* and *E. coli, S. aureus, P. aeruginosa* and

Salmonella sp, The high concentration (10µl, 20µl, 30µl) of the *Tephrosia pulcherrima* root used against the above four pathogenic organisms has showed varied degree of antibacterial activity.

CONCLUSION

It may conclude that the *Tephrosia pulcherrima* are very useful plant. It is used in the treatment of some common and other various dangerous diseases. There is a need to explore its maximum potential in the field of medicinal and pharmaceutical sciences for novel application. From the results it is concluded that the ethanol extracts *Tephrosia pulcherrima* of possess remarkable antimicrobial activity.

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Table 1: Antimicrobial activity of the stem plant extracts of *Tephrosia pulcherrima*

S.No	Cultures	Zone of Inhibition in mm			
		10µl	20µl	30µl	Antibiotic (Cefotaxime-30mcg)
1.	*Escherichia coli*	14	16	18	26
2.	*Staptococcus* sp	15	16	18	24
3.	*Staphylococcus aureus*	11	13	15	23
4.	*pseudomonas aerginose*	11	14	16	24
5.	*Salmonella* sp.	11	13	15	25

Escherichia coli   *Staptococcus sp*

Staphylococcus aureus   *Pseudomonas erginose coli*

Salmonella sp
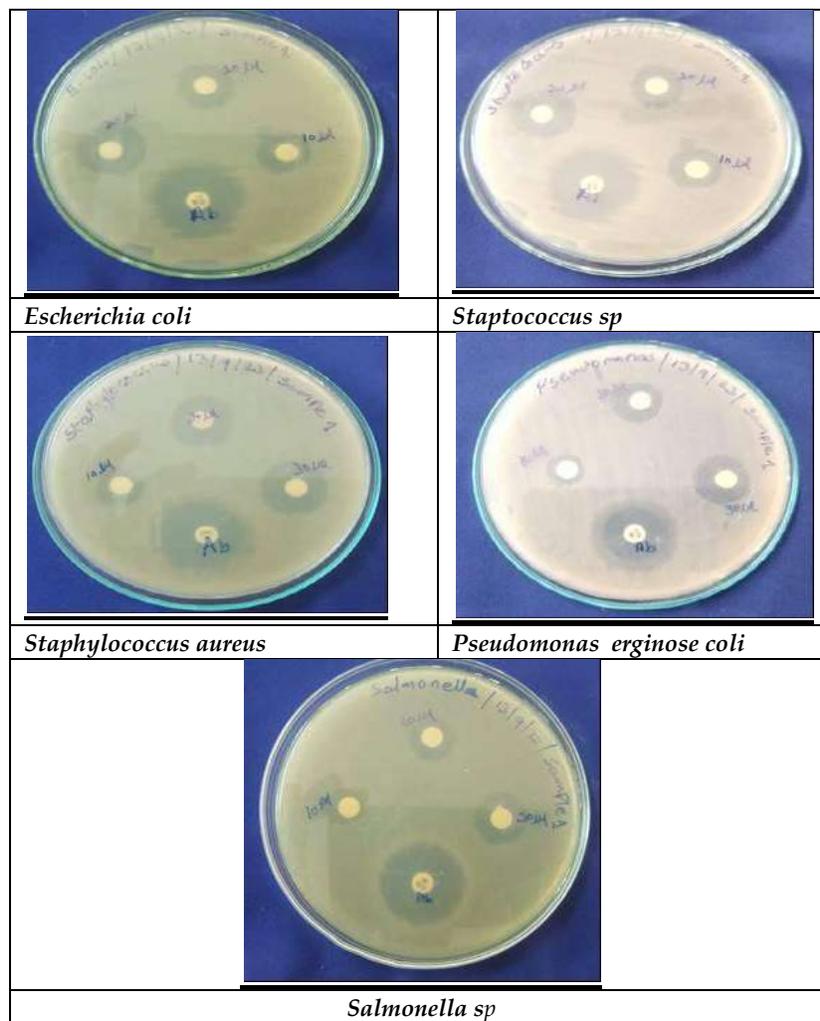
Plate. 1: Zone of Inhibition in the culture of Microbes by ethanol extract of *Tephrosia pulcherrima*

RESEARCH ARTICLE

Classifying Online Crime News: Naive Bayes Approach with Diverse Feature Extraction Technique

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ABSTRACT

News comprises a compilation of current events covering a wide array of topics, including finance, agriculture, business, economics, education, employment, entertainment, health, politics, technology, and global affairs, among others. Occasionally, when events unfold unjustly, this type of information is referred to as 'crime news.' Crime news serves as a means to provide awareness and knowledge to help prevent unlawful activities. In the realm of digital advancement, key research areas include enlargement, classification, and prediction. While many studies on news classification have focused solely on news headlines, our system emphasizes the main stories within news articles for classification purposes. Our approach involves evaluating the efficacy of the Naïve Bayes (NB) machine learning algorithm to automatically categorize news articles into 'Crime' and 'Non-Crime' segments. Raw real-world data is unsuitable for direct use in classification algorithms due to noise, missing elements, and outliers. Any of these factors can have a detrimental impact on the quality of outcomes. Thus, we have implemented text pre-processing techniques to cleanse the text. Alongside Linguistic Analysis of Text (NLP), such as the elimination of stop words and lemmatization, aimed at enhancing the dataset. The subsequent stage encompasses Feature Extraction, where we employ techniques like Counter Vectorization, N-grams, and TFIDF Vectorization to extract meaningful features from the news data. Following this, the NB algorithm is deployed to classify the news articles. The results generated by the classifier are then evaluated using measures, including precision, recall, accuracy, and the F1 score.

Keywords: Data Preprocessing, Feature Extraction, Naïve Bayes Algorithm, News Classification, Crime Classification, Confusion Matrix

INTRODUCTION

The internet's rapid advancement has effectively interconnected communities worldwide. This expansion is also evident in the realm of news media. As Philip Leslie Graham, a distinguished American newspaper publisher associated with 'The Washington Post,' astutely stated, 'News represents the initial, unpolished version of history.' News plays an indispensable role in human civilization, encompassing diverse categories such as agriculture, business, economy, education, employment, entertainment, health, politics, technology, world affairs, religion, and crime, among others. In the contemporary era, the Internet's advancement empowers individuals to access their preferred news content from virtually anywhere. Every news piece contributes to revitalizing individuals and keeping them informed about ongoing events in their local vicinity. Among various news categories, crime stands as an inevitable and persistent subject. Analogous to weeds in a field, crime has become an inseparable facet of our present reality. Engaging in actions that breach established laws constitutes a crime [10], subjecting such transgressions to legal consequences [9]. The extent of penalty for an offense is established based on its inherent nature and seriousness, following the guidelines set by the existing legal structure. While legal systems exhibit variations among countries, the foundational notion of crime remains universally relevant, even if with distinct occurrence frequencies across global regions. For instance, the illustration of India's system for dispensing justice in cases of criminal offenses is presented in Figure 1. According to this framework, promptly reporting any crime is crucial at the victim's local police station. Subsequent actions, such as investigation, arrest, and the submission of an FIR, depend on the nature and seriousness of the reported crime. The process entails meticulous interrogation and documentation, culminating in a charge sheet submission and ultimately leading to a court trial. The court plays a pivotal role in adjudicating the case, weighing aspects like bail applications and delivering a verdict after hearing both the accused and the victim [11]. Throughout these legal proceedings, news outlets provide comprehensive coverage of crime-related matters.

RELATED WORK

This phase intends to provide a succinct overview of the prior research conducted in the domain of Crime News classification Researchers have utilized a range of techniques for news classification, including procedures such as refining text, extracting features, and employing algorithms for text classification. Shilpa Singh Hanswal et al., in 2021 [5], presented a study that utilized three classification algorithms—SVC, NB, and LR—to categorize student sentiment polarity in E-learning tweets as Positive or Negative. The classification accuracy was observed as 61% for NB, 63% for LR, and 49% for SVC. The authors suggested alternative algorithms such as Multinomial NB, Bernoulli NB, SGD, and Linear SVC to potentially improve classification accuracy. Lu Wang et al., in 2020 [16], introduced an enhanced NB algorithm for distinguishing between spam and non-spam emails. Their approach combined the random forest and naive Bayesian algorithms, resulting in an improved NB algorithm with an accuracy of 85.86%.

This marked a 1.01% enhancement compared to the original NB algorithm's accuracy of 84.85%. Aashish Agarwal et al., in 2019 [1], explored the use of Krippendorf's alpha and Fleiss kappa statistical scales to classify news articles as good, neutral, or bad. They evaluated several algorithms, including SVM, LR, LSDM, and Naïve Bayes, with Naive Bayes outperforming the other classifiers. Umid Suleymanov et al., in 2018 [14], developed an automatic news classification framework for Azerbaijani news datasets. The study proposed the application of classification algorithms such as NB, SVM, and ANN. Their findings suggested that ANN exhibited superior performance compared to SVM. Mykhailo Granik et al., in 2017 [4], introduced an approach for Fake news detection in Face book news posts using the Naïve Bayes Classification algorithm, achieving an accuracy of 75.40%. The authors provided suggestions for enhancing classifier performance. José Antonio Iglesias et al., in 2016 [6], proposed an Evolving classifier based on fuzzy rules to categorize news articles into distinct categories such as health-science, arts, science-technology, and sports. They employed the Weka and Lib SVM libraries for implementation. Additionally, a web-based crime analysis system for crime hotspot detection was suggested by Jayaweera, Isuru et al., in 2015 [7]. In summary, this overview underscores the diverse methodologies employed in crime news classification and highlights the performance and potential improvements of various classification algorithms.

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METHODOLOGY

The comprehensive structure of the framework for crime classification is illustrated in Figure 2. The proposed framework consists of two significant phases: the training phase and the prediction phase. The first phase encompasses four key segments: data preparation, text pre-processing, feature extraction, and model classification. The second phase replicates the sections from the training phase, excluding the elements of data preparation and the Model Classifier. Each of these sections is succinctly addressed in the subsequent part.

Training Phase
Data Preparation: The commencement of any data analysis involves data preparation [16]. For this study, we opted for news articles from Indian Cropus. A sum of 2,781 articles was gathered for this dataset, all of which is accessible publicly. Subsequently, the acquired data was classified manually into two categories: crime and non-crime. The dataset comprises a total of 31,235 sentences and 983,256 words. Table 1 illustrates the distribution, depicting the proportion of crime and non-crime news within our dataset.

Text Pre-processing
The quality of the output is ultimately determined by the standard of the data [3]. However, in the real world, data often contains inconsistencies, missing values, outliers, and duplicates. Such data is unsuitable for algorithmic analysis. Data pre-processing represents the longest and most critical phase of the data mining and analysis process [13]. Data cleaning primarily involves removing non-textual elements from the data [15]. Within this segment, our approach initially involved mapping contractions within the text and subsequently eliminating them. The subsequent step entailed tokenization, wherein sentences were divided into distinct words. Following this, all words were converted to lowercase to achieve text normalization. The subsequent step involved removing punctuation from the normalized text. In the subsequent segment, we employed NLP techniques to eliminate stop words from the text. Finally, we applied Lemmatization techniques to transform various word forms into their base or source words, thereby reducing word dimensions [2].

Feature Extraction
Extracting correct features has a profound impact on the data analysis process. Text feature extraction involves converting text into a numerical vector format, which is a crucial step in the entire classification process. Feature extraction provides a numerical representation of text, and reducing text dimensionality significantly contributes to the enhanced performance of classification algorithms [8]. In our approach, we applied feature extraction to the pre-processed text. This phase encompassed the utilization of various feature extraction methods, including Count Vectorizer (CV), N-Grams, and Term Frequency-Inverse Document Frequency (TFIDF) Vectorizer. These methods were employed to transform text into a machine-readable vector format, thereby effectively reducing the dimensions of words.

Model Classification
Classification holds paramount importance in the entire data analysis process. Text classification involves categorizing documents into predetermined classes without the need for human intervention; this process is referred to as classification. Naïve Bayes, a probabilistic machine learning (ML) algorithm based on Bayes' Theorem, finds application in a diverse array of classification tasks [12].

$$P(y \mid X) = \frac{P(X \mid y)P(y)}{P(X)}$$

In this paper, we have employed a supervised learning approach utilizing the binary classification algorithm of Naïve Bayes to categorize news articles into crime and non-crime segments. News articles typically encompass a wide range of categorized information; for the purpose of our research, we divided the news articles into two classes:

crime and non-crime. In the first phase, we created histograms for all the words within both classes and computed the probabilities associated with each word in normal news articles. In the subsequent Naïve Bayes model formula (1), 'P' denotes probability, 'X' signifies news articles, and 'y' represents a given word in a news article. In this formula, P(y|X) indicates the probability of a word, P(X|y) denotes the probability of "y" given by X, P(y) represents the probability of 'y' occurring across all news articles, and P(X) signifies the total number of words in all news articles. We calculated the likelihoods within the histograms of words for both crime and non-crime categories. Subsequently, we compared the scores between crime and non-crime, classifying them into their respective segments if the values exceeded a certain threshold.

Algorithm 1.LexiJustice
The algorithm classifies news articles into crime-related or non-crime-related categories using text processing and machine learning. It preprocesses text, extracts features, trains a classifier, and evaluates its performance. This automates article categorization based on content.

Predication Phase
During the Prediction phase, news articles undergo classification using the output obtained from the trained classifier. This output is utilized to sort and categorize documents. In this paper, we employ real-time news articles as input for the text pre-processing segment, which processes the raw news articles. The results of the text refine segment are then subjected to extraction of features methods, converting the text pre-processed text into a vector format. The outcomes of the feature extraction phase are fed into the model classifier. Ultimately, the Model Classifier categorizes the news articles as either crime-related or non-crime-related.

EXPERIMENT AND EVALUATION
This paper presents the experimentation and evaluation results of the NB classification algorithm along with feature extraction methods. The first segment outlines the data information, followed by the classifier's most informative features, crime classification evolution metrics, confusion matrix, prediction phase results, and finally, a discussion of the overall findings. The entire experimental work was implemented using Python version 3.9.1 in Jupyter Notebook 6.0.3, alongside MS Excel.

Data Information
To align with the research objectives, this paper undertook the manual compilation of diverse data from a range of public news sources within India. For the purpose of model classification, the complete dataset was subdivided into two distinct segments: 70% designated for Training and the remaining 30% reserved for Testing. The pertinent details of this partitioning strategy are succinctly encapsulated in Table 2.

Confusion Matrix
The Confusion Matrix is a tool used to evaluate the performance of a classification algorithm. By analyzing the Confusion Matrix, one can obtain a comprehensive insight into the accuracy of the classification model and the types of errors it might produce. In Table 3, you'll find the values for metrics such as True Positive (TP) rate, False Positive (FP) rate, True Negative (TN) rate, and False Negative (FN) rate. The outcomes of the confusion matrix are outlined in Table 4. The experimental results for precision, recall, f1-score, and accuracy rates are visually depicted in a line chart shown in Figure 3.

Classifier's Most Informative Features
In this study, the most informative features of the NB Classifier are presented and depicted in Table 5. Additionally, N-Grams with the most informative features of the NB Classifier are displayed in Table 6.

Prediction Phase Result

This paper utilizes current news headlines to evaluate the trained classification classifier's performance in classifying news article headlines into crime and non-crime categories, as detailed in Figure 4.

INSIGHTS AND FINDINGS

1. When comparing the precision rate of 100% achieved by the CV with NB classifier to other models, it does not necessarily indicate that the model is performing well. This particular model misclassified 73 non-crime news articles as crime, resulting in a recall rate of 79.20%.
2. In crime news prediction, the recall (sensitivity) rate holds more significance than the precision rate. The recall rates for TFIDF with NB and N-Grams with NB are 85.11% and 85.28%, respectively. These values effectively reduce the False Negative (FN) rate.
3. Combining the NB classification algorithm with TFIDF and N-Gram Feature Extraction leads to more effective performance, yielding accuracies of 93.25% and 93.05%, respectively. TFIDF outperforms N-Gram Feature Extraction by 0.24%.
4. Feature words such as "Sexually" and "murder" exhibit high crime probability scores.
5. The feature word "covid" holds a high non-crime probability score.
6. Certain Unigrams words like 'ipc', 'sexually', 'murder', 'injuries', and 'investigating' demonstrate high crime probability scores.
7. The Bi-Grams word "('police', 'arrested')" showcases a high crime probability score.
8. The Tri-Grams word "('bench', 'madras', 'high')" attains a high crime probability score.
9. The 4-Grams word "('bench', 'madras', 'high', 'court')" achieves a high crime probability score.

CONCLUSION AND FUTURE DIRECTION

In conclusion, this study introduces a novel and effective approach to classifying crime-related news articles by combining feature extraction methods with the Naïve Bayes algorithm. Unlike conventional methods, which often rely solely on headlines, our approach harnesses the entirety of the main story text for more accurate classification. By manually tagging news articles and employing advanced text processing techniques, we prepare the data for feature extraction using CV, N-Gram, and TFIDF methods. The subsequent application of the Naïve Bayes algorithm, with a focus on various feature combinations, highlights the superiority of TFIDF, achieving an impressive accuracy of 93.29%. Our research provides not only valuable practical insights, such as the influence of hardware limitations and the importance of careful sampling, but also a foundational framework for news article classification within the realm of machine learning. As we look ahead, this work opens doors to further exploration, including the integration of sentiment analysis to personalize news recommendations and the adoption of cross-validation techniques to bolster model accuracy. Ultimately, our approach offers a significant contribution to the field, driving advancements in the classification of news articles and inspiring future research endeavors.

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Table 1. Distribution of News Article Categories

Types of News Articles	Articles Counts	Aggregate Sentence	Aggregate Words	Percentage to total
Crime	1206	12687	413331	43.37
Non Crime	1575	18548	569925	56.63

Algorithm 1: LexiJustice(Text-Based Algorithm for Crime Categorization)
Input: News Data
Outcome: Classified data
1: Start the process
2: Initialize the input data list crm = [T1, T2, T3…,Tn] || ncrm = [T1, T2, T3…,Tn]
3: Read all text documents from crm&ncrm
4: For each tuple crm> 0 &ncrm> 0

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If(document extension contains (".txt")
Mapped the Contraction and normalize the text
Tokenized the text
Make text lowercase
Remove punctuation, URLs and containing numbers.
Remove the stop words
Lemmatised the text
End If
5: Repeat the Step 4 until EOF encountered
6: Implement the feature from pre-processed data using CV ‖TF-IDF ‖ N -Grams
7: Repeat the Step 6 until EOF encountered
8: create word features form (Step 6) ‖ create N-Gram features (Step 6)
9: Repeat the Step 8 until EOF encountered
10: Combined the crm and ncrm list from (Step 8)
11: Randomly shuffled the combined list
11: Spilt the combined list into training and testing list
12: Classification algorithm applied training data to train the Model
13: Trained Classifier model classifies the news with testing data
14: Evaluate the model performance and outcome
15: Stop the process

Table 2. Data Partitioning Overview

Data	Articles
Total data set	2781
Training data Set	1946
Testing data Set	835

Table 3. Feature Extraction with Classifier Confusion Matrix

Classifiers	TP Rate	FP Rate	FN Rate	TN Rate
TFIDF+NB	303	3	53	476
N-Grams + NB	313	4	54	464
NB	303	1	69	462
CV+NB	278	0	73	484

Table 4. Classification Confusion Matrix

Classifiers	Precision Rate (%)	Recall Rate (%)	F1-Score Rate (%)	Accuracy Rate (%)
CV+NB	100	79.20	88.39	91.25
NB	99.97	81.45	89.64	91.61
N-Grams + NB	98.73	85.28	91.52	93.05
TFIDF+NB	99.01	85.11	91.54	93.29

Table 5. Naïve Bays Classifier most informative features

Features	Probability score
sexually = True	crime : non_crime = 70.6 : 1.0

murder = True	crime : non_crime = 58.4 : 1.0
duo = True	crime : non_crime = 58.4 : 1.0
covid = True	non_crime : crime = 46.3 : 1.0
allegedly = True	crime : non_crime = 42.8 : 1.0
ipc = True	crime : non_crime = 41.3 : 1.0
inspector = True	crime : non_crime = 40.8 : 1.0
penal = True	crime : non_crime = 38.2 : 1.0
girl = True	crime : non_crime = 37.0 : 1.0

Table 6. N-Grams with Naïve Bays Classifier most informative features

Features	Probability score
('ipc',) = True	crime : non_crime = 65.5 : 1.0
('police', 'arrested') = True	crime : non_crime = 65.5 : 1.0
('sexually',) = True	crime : non_crime = 64.6 : 1.0
('duo',) = True	crime : non_crime = 55.0 : 1.0
('bench', 'madras') = True	crime : non_crime = 48.8 : 1.0
('murder',) = True	crime : non_crime = 48.1 : 1.0
('bench', 'madras', 'high')= True	crime : non_crime = 47.9 : 1.0
('bench', 'madras', 'high', 'court') = True	crime : non_crime = 47.0 : 1.0
('injuries') = True	crime : non_crime = 45.3 : 1.0
('investigating') = True	crime : non_crime = 45.3 : 1.0
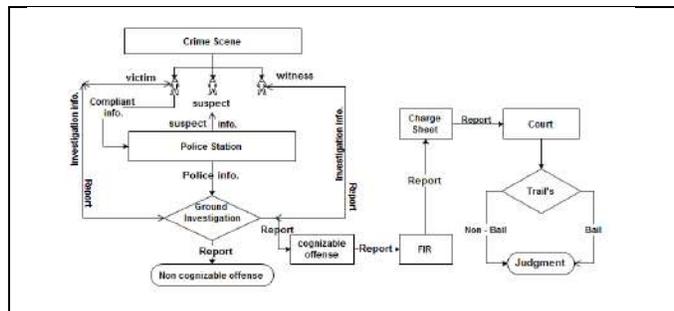
Figure 1. Crime system in India
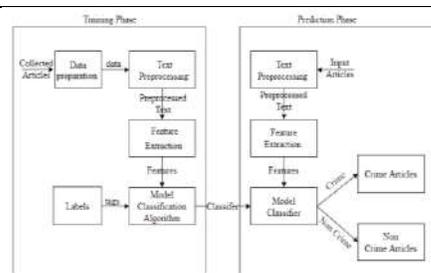
Figure 2. Crime Classification framework
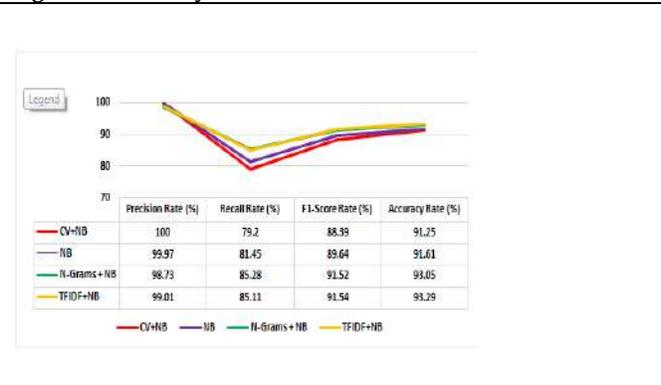
Figure 3. Experiment results and precision, recall, f1-score, accuracy rates

Figure 4. News Headline classification Result

RESEARCH ARTICLE

Determination of Preferences of Soils in Cultivated Lands of Twenty Five Places in Thanjavur District by using Updated Fuzzy Topsis Method

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ABSTRACT

A different parts of the world are developing in agriculture based on the quality of water and soil. These qualities can be evaluated by using different method for selecting the preferences of the selected areas. Considering the soils for some regions which has different chemical parameters and their parameters can be computed by using the TOPSIS Method. Here, the solution of Fuzzy TOPSIS method is got by evaluating from fuzzy positive and fuzzy negative ideal solutions in various characteristics of soil from different locations, in which the Updated Fuzzy TOPSIS Method obtained by updating the procedure for Fuzzy TOPSIS Method, gives the moderate solution for the problem. Our objective of the paper is to determine the selection of the place with high quality soil among the twenty five different locations given.

Keywords: Chemical parameters, Multi Criteria Decision-Making, Fuzzy TOPSIS, Updated Fuzzy TOPSIS Method.

INTRODUCTION

Soil are mixture of different things; rocks, minerals and dead decaying plants and animals. Although the composition of soil can vary from one place to another, it typically consists of water, air and both organic and inorganic materials. The inorganic materials are the rocks that have been broken down into smaller pieces. It may appear as pebbles, gravel, or as small as particles of sand clay. The organic material is decaying living matter. This could be plants or animals that have died and decay until they becomes part of the soil. The amount of water in the soil is closely linked with the climate and other characteristics of the region. The amount of water in the soil is one thing that can affect the amount of air. Very wet soil each are found in a wetland probably has very little air. A different parts of the world are developing in agriculture based on the quality of water and soil . These qualities can be evaluated by using different method for selecting the preferences of the selected areas. Considering the soils for some regions which has different chemical parameters and their parameters can be computed by using the TOPSIS Method. Here, the solution of Fuzzy TOPSIS method is got by evaluating from fuzzy positive and fuzzy negative ideal solutions in various characteristics of soil from different locations, in which the Updated Fuzzy TOPSIS Method obtained by updating the procedure for Fuzzy TOPSIS Method, gives the moderate solution for the problem. Our objective of the paper is to determine the selection of the place with high quality soil among the twenty five different locations given. Mixtures of mineral and organic particles of varying size compose of soil. The particles occupy about 50 per cent of the soil's volume. The remaining soil volume composed of pores of varying shapes and sizes.

The pore spaces contain air and water and serve as cannels for the movement of air and water. Pore spaces are used as runways for small animals and are avenues for the extension and growth of roots. Roots anchored in soil support plants and roots absorb water and nutrients. For good plant growth, the root-soil environment should be free of unwanted factors. The three essential things that plants absorb from the soil are: *(1) water* that is mainly evaporated from plant leaves, *(2) nutrients* for nutrition, and *(3) oxygen*for root respiration. Such challenges are solved using MCDM techniques while taking into account a wide range of variables[Yu et al. 2011(11); Nillsson et al. 2016(9)]. Due to its benefits, such as case of execution regardless of the number of alternatives and criteria as well as its ability to yield effective result, the methodology for order preference by similarity to an ideal solution in (TOPSIS) method is extensively used in the MCDM process. The TOPSIS techniques is based on the premise that different solutions should be ranked in accordance with specific criteria and between the maximum and minimum values that the criterion can have in accordance with the optimal solution. Determining attribute weights is a step that must be taken when using TOPSIS [Hwang and Yoon 1981(5)]. To identify this flow in the standard TOPSIS the fuzzy TOPSIS technique was suggested in which the weights of criteria and ratings of alternatives are evaluated by linguistic variables represented by fuzzy integers. Numerous industries, including those in the sectors of energy, the environment, industrial process and climate change, have successfully used the fuzzy TOPSIS Techniques [Beskese, A.; Demir, H.H.; Ozcan, H.K.; Okten, H.E. 2015(1), Cavallaro, F.; Zavadskas, E.K.; Raslanas, S. 2016(2), Guo, S.; Zhao, H. 2015(4)]. The evolution of soil quality during the process of land reclamations is still unknown, despite widespread reporting of temporal fluctuations in soil quality on farmlands, forests, and wetlands[Raiesi and Kabiri 2016(10); Nabeollahi et al. 2017(8); Yang et al. 2017(11); Zhang et al. 2019(14)].

The changes in soil characteristics caused by anthropogenic activity can be seen in the quality of the soil[Karlen et al. 1993(6)]. Due to the growing focus on sustainable land use and food security, assessments of soil quality have drawn a lot of attention [Liu et al. 2015(7)]. To assess the progress and success reclaimed coastal saline soil, it is crucial to identify the representative indicators, which should contain the basic physical, chemical, and biological aspects[Zhang et al. 2011(13)]. The soil systems are complex and variable, the accuracy of assessment results is heavily dependent on appropriate analysis techniques [Guo et al. 2017(3)]. After each cropping system was finished seasonal estimates of the available N, P, K and soil organic C were made 25 areas in Thanjavur town. For each of the twenty-five areas in Thanjavur town, soil quality criteria were examined. From soil samples, it was also possible to estimate the concentration of soil organic C, available N, and available P. In the present investigation, twenty five ground water resources were selected to study the quality of groundwater to subject to analysis using UPDATED

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FUZZY TOPSIS Method (UFTM).Due to population growth, the intensive agricultural production plan can be updated by adopting the methods in using chemical quality and extrapolated parameters of soil *viz.,* EC, pH, N,P and K. Analysis of soil was carried out at Agricultural College And Research Institute, Tamil Nadu Agricultural University Eachangkottai, Thanjavur. The soil parameters*viz.,* EC, pH, N,P and K were analyzed. The places were selected in and around Thanjavur at a distance of 25km from the heart of the city and chosen for conducting the study. The samples were collected from the following 25 places *viz.,* 1.kattur,2,.Raramuthraikottai,3.Oolur,4.Villar, 5.Kulichappattu,6.Duraioor,7.Thalavapalayam,8.Marungulam,9.Vandaiyaruppu,10.Valamarakottai,11.Thiruvonam,12.Vadakkupattu,13.Kattuthottam,14.Kalakudi,15.Medicalcollege,16.Ponnapoor,17.Branthai,18.Kattukurichi,19.Saliya mangalam,20.Puliyakkudi,21.Kollangkarai,22.Nellupattu,23.Marungai,24.Nangikottai,25.Mariyammankovil.Afterup dating the formula in TOPSIS named UPDATED FUZZY TOPSIS in the normalized fuzzy decision matrix and fuzzy +ve and fuzzy –ve ideal solutions in different quality parameters of groundwater, the best preference place among twenty five selected places was identified.

Procedure of Updated Fuzzy TOPSIS Method

Making choices among numerous alternatives that are characterized by multiple, typically competing criteria is a common step in the decision- making process. The representative decision matrix $\mathbb{P}$ used in MCDM. Where C_j represent the decision criteria(j=1,2,3,4,…n) B_i represent the alternatives (i=1,2,3,4…m), and q_{ij} represent the value of the ith alternative under the jth criteria w_j(j=1,2,3,4…n) are the criteria fuzzy weights indicating the relative importance among them.

STEP 1

The Fuzzy Normalized Decision Matrix in TOPSIS the performance of each alternative needs to be graded with equation

$$Pij = \frac{q_{ij}}{\sum_{i=1}^{m} q_{ij}}\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots \tag{1}$$

With $\mathbb{P}$ decision matrix, is $\mathbb{P}= [p_{ij}]$; where $\mathbb{P}$ =

$$\begin{array}{c} C/A \quad C_1 \quad C_2 \quad \cdots \quad C_n \\ \begin{matrix} B_{11} \\ B_{12} \\ \cdots \\ B_{1n} \end{matrix} \begin{bmatrix} p_{11} & p_{12} & \cdots & p_{1n} \\ p_{21} & p_{22} & \cdots & p_{2n} \\ \cdots & \cdots & \cdots & \cdots \\ p_{m1} & p_{m2} & \cdots & p_{mn} \end{bmatrix} \end{array}$$

i=1,2,3,4……..m and

j=1,2,3,4,…..n. where B is a alternative and C is criteria.

STEP 2

Obtain the fuzzy weight W_j from the given the normalized decision matrix under the following conditions.

$$\sum_{j=1}^{n} W_j = 1,\text{with j=1,2,3,4,……n.}\dots\dots\dots\dots \tag{2}$$

Where fuzzy weights $w_j = \frac{w_j}{\sum_{j=1}^{n} w_j}$

STEP 3

The fuzzy weighted normalized decision matrix as follows.

$$N_{ij}=w_j(p_{ij}); \text{ with i=1,2,3,….m and j=1,2,3,4,….n…} \tag{3}$$

STEP 4

Determine +ve and -ve ideal Solution. Positive ideal solution B^+ and negative ideal solution B^- can be determine based on the fuzzy weighted normalized (N_{ij}) as:

$B^+ = (n_1^+,n_2^+,………n_n^+)$ where $n_j^+ = (\max N_{ij}/j\epsilon J)$and

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B⁻ = (n₁⁻,n₂⁻…………..nₙ⁻)   where $n_j^- = (\min N_{ij}/j \epsilon J)$

STEP 5

The distance of each alternative from Positive and Negative ideal solution. The distance alternatives B⁺ with Positive ideal solution can be formulated with equation.

$$T_i^+ = \sum_{j=1}^n |n_{ij} - n_j^+| ; i=1,2,3,\ldots\ldots m,\ldots\ldots\ldots\ldots\ldots \tag{4}$$

The distance between alternative B⁻ with negative ideal solution can be formulated with equation.

$$T_i^- = \sum_{j=1}^n |n_{ij} - n_j^-| ; i=1,2,3,4,\ldots\ldots m \ldots\ldots\ldots\ldots.. \tag{5}$$

Where $n_{ij} = N_{ij}$ is the fuzzy weighted normalized decision matrix.

STEP 6

Determining the values of preference for each alternative(C_i) is given as:

$$(BATD)C_i = \frac{T_i^-}{T_i^+ + T_i^-} \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \tag{6}$$

Since $T_i^- \geq 0$ and $T_i^+ \geq 0$, then $C_i \epsilon[0,1]$ Where BATD is best area in thanjavur district.

Normalizing the vectors for each of the above mentioned quantities. Fuzzy weights are calculated by dividing the sum of each soil parameter by the grand total of all components. Multiply the fuzzy weights of each parameter with the quantity of normalization of each parameter of soil. T_i^+ has to be evaluated by using the equation (4) and T_i^- has to evaluated by using the equation(5). Finally the value of the preference must be calculated and they find out the order of preferences for these values.

CONCLUSION 1

Soils from 25 different places of agricultural land were tested using Updated Fuzzy TOPSIS method(UFTM). The samples are preference values from cultivated land must be evaluated by using fuzzy +ve and fuzzy –ve ideal solutions and then soil of cultivated land can be added by taking the ranking of the criteria(C_i's) values for all these places. This methods can be followed for any samples parameter of cultivated lands such as temperature, quality of seeds, manure, water samples etc…, by taking their preference. This method can be used to obtain the best preference of the analysis samples.

CONCLUSION

From the fact and procedure above among 25 soil samples of cultivated land, the alternatives A₂₃rd places viz., kattithotam, ranked first and it is selected as best preferences, A₄th alternatives places is kalakudi ranked second, and it is selected as next preferences, and vice versa. Finally the alternatives 15th area the vandaiyaruppu ranked 25th and it is selected as last preferences.

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Table:1 Measures for the 25 different soil components in thanjavur district.

Criteria Alternatives	C_1 Village Name	C_2 pH	C_3 EC	C_4 Nitrogen(N)	C_5 Phosphorus(P)	C_6 Potassium(K)	TOTAL
B_1	Marungulam	6.11	0.22	137.98	20.16	134	298.47
B_2	Oolur	6.25	0.27	150.52	6.72	56	219.76
B_3	Villar	5.9	0.22	112.89	8.96	33.6	161.57
B_4	Kalakudi	7.65	0.51	188.16	24.64	280	500.96
B_5	Mariammankovil	5.5	0.26	163.07	4.48	78.4	251.71
B_6	Kattur	6.73	0.43	200.7	56	89.6	353.46
B_7	Raramuthraikottai	5.22	0.26	125.44	8.96	22.4	162.28
B_8	Kattukurichi	5.6	0.42	175.61	15.68	22.4	219.71
B_9	Nangikottai	5.39	0.23	163.07	4.48	11.2	184.37
B_{10}	Kollangkarai	5.6	0.3	163.07	60.48	44.8	274.25
B_{11}	Valamarakottai	5.83	0.24	175.61	24.6	44.8	251.08
B_{12}	Branthai	6.26	0.27	175.61	5.6	190.4	378.14
B_{13}	Kulichappattu	5.51	0.37	163.07	35.84	56	260.79
B_{14}	Ponnapoor	7.1	0.47	175.61	78.4	235.2	496.78
B_{15}	Vandaiyaruppu	4.97	0.26	125.44	9.2	22.4	162.27
B_{16}	Nellupattu	5.96	0.26	188.16	8.96	44.8	248.14
B_{17}	Saliyamangalam	6.01	0.23	163.07	22.4	33.6	225.31
B_{18}	Medical college	7.27	0.23	213.24	58.24	100.8	379.78
B_{19}	Puliyakkudi	5.29	0.28	163.07	56	112	336.64
B_{20}	Thiruvonam	6.13	0.3	137.98	24.64	44.8	213.85
B_{21}	Marungai	5.9	0.35	175.66	4.48	78.4	264.79

B_{22}	Duraioor	6.01	0.35	188.16	6.72	67.2	268.44
B_{23}	Kattuthottam	6.3	0.27	200.7	20.16	302.4	529.83
B_{24}	Vadakkupattu	5.74	0.35	150.52	17.92	112	286.53
B_{25}	Thalavapalayam	4.91	0.26	188.16	8.96	89.6	291.89
TOTAL	149.14	7.61	4164.57	592.68	2306.8	7220.8	

Table 2: Normalized Fuzzy Decision Matrix

Criteria Alternatives	C_1 Village Name	C_2 pH	C_3 EC	C_4 Nitrogen(N)	C_5 Phosphorus(P)	C_6 Potassium(K)
B_1	Marungulam	0.040968218	0.02890933	0.033131872	0.034014983	0.058089128
B_2	Oolur	0.041906933	0.035479632	0.036142987	0.011338328	0.024276053
B_3	Villar	0.039560145	0.02890933	0.02710724	0.01511777	0.014565632
B_4	Kalakudi	0.051294086	0.067017083	0.045181135	0.041573868	0.121380267
B_5	Mariammankovil	0.036878101	0.034165572	0.039156504	0.007558885	0.033986475
B_6	Kattur	0.045125386	0.056504599	0.04819225	0.094486063	0.038841685
B_7	Raramuthraikottai	0.035000671	0.034165572	0.030120757	0.01511777	0.009710421
B_8	Kattukurichi	0.037548612	0.055190539	0.042167619	0.026456098	0.009710421
B_9	Nangikottai	0.036140539	0.03022339	0.039156504	0.007558885	0.004855211
B_{10}	Kollangkarai	0.037548612	0.039421813	0.039156504	0.102044948	0.019420843
B_{11}	Valamarakottai	0.039090787	0.031537451	0.042167619	0.041506378	0.019420843
B_{12}	Branthai	0.041973984	0.035479632	0.042167619	0.009448606	0.082538582
B_{13}	Kulichappattu	0.036945152	0.048620237	0.039156504	0.060471081	0.024276053
B_{14}	Ponnapoor	0.047606276	0.061760841	0.042167619	0.132280489	0.101959424
B_{15}	Vandaiyaruppu	0.033324393	0.034165572	0.030120757	0.003988209	0.009710421
B_{16}	Nellupattu	0.039962451	0.034165572	0.045181135	0.01511777	0.019420843
B_{17}	Saliyamangalam	0.040297707	0.03022339	0.039156504	0.037794425	0.014565632
B_{18}	Medical college	0.048746145	0.03022339	0.051203366	0.098265506	0.043696896
B_{19}	Puliyakkudi	0.035470028	0.036793693	0.039156504	0.094486063	0.048552107
B_{20}	Thiruvonam	0.04110232	0.039421813	0.033131872	0.041573868	0.019420843
B_{21}	Marungai	0.039560145	0.045992116	0.042179625	0.007558885	0.033986475
B_{22}	Duraioor	0.040297707	0.045992116	0.045181135	0.011338328	0.029131264
B_{23}	Kattuthottam	0.042242189	0.035479632	0.04819225	0.034014983	0.131090688
B_{24}	Vadakkupattu	0.038487327	0.045992116	0.036142987	0.03023554	0.048552107
B_{25}	Thalavapalayam	0.032922087	0.034165572	0.045181135	0.01511777	0.038841685
FUZZY WEIGHTED:	0.020654221		0.0010539	0.576746344	0.082079548	0.319465987

Table:3 The fuzzy weighted normalized decision matrix.

Criteria Alternatives	C_1 Village Name	C_2 pH	C_3 EC	C_4 Nitrogen(N)	C_5 Phosphorus(P)	C_6 Potassium(K)
B_1	Marungulam	0.000846167	3.04675E-05	0.019108686	0.002791934	0.018557501
B_2	Oolur	0.000865555	3.7392E-05	0.020845336	0.000930645	0.007755373
B_3	Villar	0.000817084	3.04675E-05	0.015634002	0.00124086	0.004653224
B_4	Kalakudi	0.001059439	7.06293E-05	0.026058055	0.003412364	0.038776867
B_5	Mariammankovil	0.000761688	3.60071E-05	0.02258337	0.00062043	0.010857523
B_6	Kattur	0.00093203	5.95502E-05	0.027794704	0.007755373	0.012408597

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B_7	Raramuthraikottai	0.000722912	3.60071E-05	0.017372036	0.00124086	0.003102149
B_8	Kattukurichi	0.000775537	5.81653E-05	0.02432002	0.002171505	0.003102149
B_9	Nangikottai	0.000746455	3.18524E-05	0.02258337	0.00062043	0.001551075
B_{10}	Kollangkarai	0.000775537	4.15466E-05	0.02258337	0.008375803	0.006204299
B_{11}	Valamarakottai	0.00080739	3.32373E-05	0.02432002	0.003406825	0.006204299
B_{12}	Branthai	0.00086694	3.7392E-05	0.02432002	0.000775537	0.026368269
B_{13}	Kulichappattu	0.000763073	5.12409E-05	0.02258337	0.004963439	0.007755373
B_{14}	Ponnapoor	0.000983271	6.50897E-05	0.02432002	0.010857523	0.032572568
B_{15}	Vandaiyaruppu	0.000688289	3.60071E-05	0.017372036	0.00032735	0.003102149
B_{16}	Nellupattu	0.000825393	3.60071E-05	0.026058055	0.00124086	0.006204299
B_{17}	Saliyamangalam	0.000832318	3.18524E-05	0.02258337	0.003102149	0.004653224
B_{18}	Medical college	0.001006814	3.18524E-05	0.029531354	0.008065588	0.013959672
B_{19}	Puliyakkudi	0.000732606	3.87769E-05	0.02258337	0.007755373	0.015510747
B_{20}	Thiruvonam	0.000848936	4.15466E-05	0.019108686	0.003412364	0.006204299
B_{21}	Marungai	0.000817084	4.84711E-05	0.024326944	0.00062043	0.010857523
B_{22}	Duraioor	0.000832318	4.84711E-05	0.026058055	0.000930645	0.009306448
B_{23}	Kattuthottam	0.00087248	3.7392E-05	0.027794704	0.002791934	0.041879016
B_{24}	Vadakkupattu	0.000794926	4.84711E-05	0.020845336	0.002481719	0.015510747
B_{25}	Thalavapalayam	0.00067998	3.60071E-05	0.026058055	0.00124086	0.012408597

B^+: 0.001059439 7.06293E-05 0.029531354 0.010857523 0.041879016

B^-: 0.00067998   3.04675E-05 0.015634002 0.00032735   0.001551075

Table:4 The Best Preference Of Soil In 25 Areas

Alternatives	VILLAGE NAME	$T_i^+ = \|n_{ij} - n_j^+\|$	$T_i^- = \|n_{ij} - n_j^-\|$	$C_j = T_i^- / T_i^+ + T_i^-$	Rank
B_1	Marungulam	0.042063206	0.023111881	0.354612198	8
B_2	Oolur	0.052963661	0.012211426	0.187363408	19
B_3	Villar	0.061022324	0.004152763	0.063717025	24
B_4	Kalakudi	0.014020607	0.05115448	0.784877817	2
B_5	Mariammankovil	0.048538943	0.016636144	0.255253115	15
B_6	Kattur	0.034447707	0.03072738	0.471458983	6
B_7	Raramuthraikottai	0.060923997	0.00425109	0.065225685	23
B_8	Kattukurichi	0.052970585	0.012204502	0.187257165	20
B_9	Nangikottai	0.05786478	0.007310308	0.112164138	21
B_{10}	Kollangkarai	0.045417405	0.00445103	0.089255464	22
B_{11}	Valamarakottai	0.048626191	0.016548896	0.253914445	16
B_{12}	Branthai	0.031029803	0.034145284	0.52390086	5
B_{13}	Kulichappattu	0.047281465	0.017893622	0.274546964	14
B_{14}	Ponnapoor	0.01459949	0.050575597	0.775995848	3
B_{15}	Vandaiyaruppu	0.061872129	0.003302958	0.050678231	25
B_{16}	Nellupattu	0.049033348	0.016141739	0.247667317	17
B_{17}	Saliyamangalam	0.052195048	0.012980039	0.199156455	18
B_{18}	Medical college	0.030802681	0.034372406	0.527385655	4
B_{19}	Puliyakkudi	0.036777088	0.028397999	0.435718617	7
B_{20}	Thiruvonam	0.024321405	0.011392958	0.319002127	11
B_{21}	Marungai	0.046727509	0.018447578	0.283046461	13
B_{22}	Duraioor	0.046222025	0.018953062	0.290802248	12

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B23	Kattuthottam	0.010022435	0.055152652	0.846222913	1
B24	Vadakkupattu	0.043716763	0.021458324	0.329241206	10
B25	Thalavapalayam	0.042974463	0.022200624	0.340630527	9
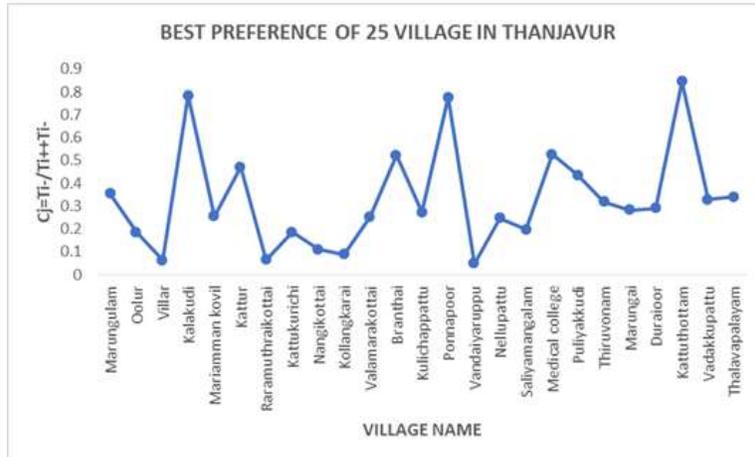
Fig:1 The point represent the values of the preference for corresponding village in Thanjavur town.

RESEARCH ARTICLE

Evaluation and Formulation of the Self-Nano Emulsifying Drug Delivery Systems

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ABSTRACT

Formulation of the SNEDDS can be the potential product of oral pharmaceutics with a higher capacity for drug loading. This can improve the dissolution of drugs, can increase gut permeation, no or reduced RBC toxicity in humans as well as enhanced oral bioavailability. Another major advantage of the drug is found in its solidification compound state, which helps in the drug delivery system. Instead of fragile system delivery, this concerned system helps in delivering water-soluble compounds through is solidified form. The composition of oil-in-water nano emulsion helps to increase bioavailability. It also helps in preventing gastric irritation and enzymatic degradation via stability and low permeability. Apart from that, it makes the overall drug delivery system less costly and more convenient.

Keywords: Self-emulsifying drug, Hydrophilic, Nano emulsions, Lipophilic drugs

INTRODUCTION

Lipid-based preparation like "self-emulsifying drug delivery systems" or SEDDS, "self-nano emulsifying drug delivery systems" or SNEEDS has been explored in several studies to the argument on the bioavailability of the high lipophilic drugs [2]. The below figure depicts the entire drug delivery system of nano emulsion. SNEDDS can encompass the mixtures of isotropic of surfactants and oils with one or several "hydrophilic" co-surfactants or co-solvents. This preconcentrate of nano emulsion systems can emulsify while dispersed within an medium of aqueous under minimum confrontation for forming O/W nano emulsion along with globule and the size can be < 100 nm [1][3]. SNEEDSs mixture of anhydrous and homogenous liquids is consisting of surfactant, oil, drug, or the

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solubilizer and co-emulsifier. These can outward appearance oil in the water nanoemulsion spontaneously of nearly 200mm on dilution along with the water under the mild stirring.

AIM

The aim of this objective is to determine the formulation with the evaluation of SNEDDS.

OBJECTIVES

- To identify the concept of the SNEDDS
- To determine the advantages of the SNEDD
- To evaluate the applications of the SNEDDS

ADVANTAGES OF THE SNEDDS

"Self nanoemulsifying formulations" or SNEF can improve the solubility of low aqueous, gastric irritation, low permeability, stability, and, enzymatic degradation. Delivery of targeted drug and site specificity can be successfully achieved by SNEF [4][5].The key advantages of nanoemulsions are huge surface area, low viscosity, and the translucent or transparent, capacity of high solubilization as well as protection of the active compounds encapsulated. From the below figure, it can be seen that there are different phases in the "Water in-oil nanoemulsion" like the oil phase, and water phase. Nanoemulsion has rapid digestibility, good stability, and effective protection against degradation, as well as it, is highly capable of enhancing the bioavailability of drugs. Furthermore, nanoemulsion may be fabricated with great flexibility for delivering various drug moieties along with several characteristics [7]. The oil phase can be developed through using various types of oils and lipids like essential oils and triglycerides for producing nanoemulsions of different biological and physicochemical properties. The water phase of the"Water in-oil nanoemulsion" can be manipulated by adding different types of components that can be water-soluble [8][9].

APPLICATION OF THE "NANOEMULSION DRUG DELIVERY SYSTEMS"

Nanoemulsion has various applications that have been given in the below picture such as targeted therapy, topical delivery, oral, parental delivery, and others [10]. SNEDDS is considered the advanced method to deliver and improve the bioavailability of hydrophobic drugs as well as other drugs that have higher "first-pass metabolism". Nanoemulsion can be formulated by both low-energy and high-energy methods. This sustained delivery of drugs can decrease toxicity related to drugs and can increase compliance of the patient with less but fewer dosing. This technology has already proven effective in the treatment of AIDS, cancer, and several diseases [11].This Nanotechnology can provide advancement within diagnostic testing. SNEDDS formulated different types of formulations like foams, liquids, sprays, and gels. This is used as the Nanoemulsion within the pharmaceutical field and for systems of drug delivery such as topical, parental nutrition, and oral.

METHODOLOGY

Design of formulation of the Nano emulsifying liquid
The formulation of the self-emulsifying was prepared by using various semi-synthetic or natural oil, hydrophilic or lipophilic surfactants as well as cosolvents that are water-soluble. There are several variants of excipients that were made for establishing a range of "self-emulsifying compositions" [12]. The entire range of the alternative formulation or the formulation from LFCS I type to type IV was studied by using various components like M812, COFA,CMCM, and TC through changing a single excipient at a moment.

Method of visual assessment

This method can be used for determining various properties of self-emulsification in the formulation. For the competence of self-emulsifying, the visual method of assessment has the strength to minimize the extreme consumption of chemicals. On the other hand, the size of the droplet, PDI, or "poly dispersity index" as well as the zeta potential of every representative that diluted formulation or alternative formulation systems [15][13]. These were measured by the analysis of"laser light diffraction".

"Transmission electron microscopy analysis" or TEM

The study was of the TEM, samples had appropriately diluted in water. A drop of diluted samples was placed upon a 300-mesh copper grid that was coated by carbon (Ted Pella).The grid had left for a minimum of 5 minutes for setting down droplets and then 1 percent phosphotungstic acid was added to the grid [12]. In the end, the dried grid had visualized beneath theJEM1010, Jeol TEM at the in use voltage of 80kv.

RESULT AND DISCUSSION

Design for the SNEDDSs

SNE nature of the different formulations on the water diffusion shows various degrees of lucidity that is ranging from the clear to milky suspension of formulations. Store formulations had optimized based on the efficiencies of "self-emulsification" or SE [12].The composition of every formulation as well as the appearance of water dispersion is presented in the below figure [10].The system shows the composition of the excipients used in every formulation on the water dispersion. F and AF refer to the formulation and alternative formulation in the below figure [14]. This assessment had done under a specific to visualize the condition system of self-emulsification.

The consequence of the hydro philicity formulation on the size of droplets

The impact of the components that are water soluble in various AF As well as F formulations is based on the disparity of the size of the droplet as well as PDI that have already been given in the below figure. Formulation of type IV continued the highest concentration of the components that are water-soluble produced the minimum droplets that is F7, 32.57 nm on the dilution along with the water. The major size of droplets was formed with the formulation of type I, which is AF1, 1274 nm, PDI- 0.88 as this contained 100 percent oils as well as formulation, had poorly dispersed into the water [14].Type II or AF2 formulation contained zero to two percent materials that are soluble in water. The droplet size dropped to 231.42 nm and the value is low of PDI 0.22 that is mono dispersed. However, for the increased amount of "water-soluble materials" from 40 to 80% within types IIIB and IIIA formulations .Here the size of the droplets was reduced to the range of 62 to 35nm [15].Among every formulation system, F6 can be considered the more stable system as its small size of droplets, which is 35.99 nm as well as the lower value of PDI.

Visual assessment method

In the below figure, it can be seen that the visually milky, with the lipophilic surfactant, is higher in size than the droplet. These samples can be used in drug-loaded formulations. The method of Visual assessment was utilized as the guideline to evaluate the homogeneity, miscibility, and appearance of every formulation.This assessment of every type of III and IV formulations determined that emulsion could form on dilution along with the water that can be physically stable intended for months [15].Both hydrophilic and lipophilic surfactants with the HLB10 to 14 were able to uphold the SE of oils. On the other hand, emulsions of resulting related to F2,AF2, F3, and Type II appeared in the crude.

CONCLUSION

SNEDDS approach can be used for the improvement of solubility of low water-soluble drugs like sertraline. Initially, the screening of the formulation of the nanoemulsion had carried out by the influence of surfactant, oils as well as co-surfactant upon the efficiency of dissolution, size of the globule including time of self-emulsification. The below results show that LFCS type III B is SNEDDS, which is liquid-based and can be determined as the potential vehicle to get the high-loading drums, improvement of dissolution, digestion, and permeation of the drugs that are poorly soluble.

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(Source: 3)	(Source: 7)
Figure 1: "Self-Nanoemulsifying Drug Delivery Systems	**Figure 2: Water in-oil nanoemulsion**
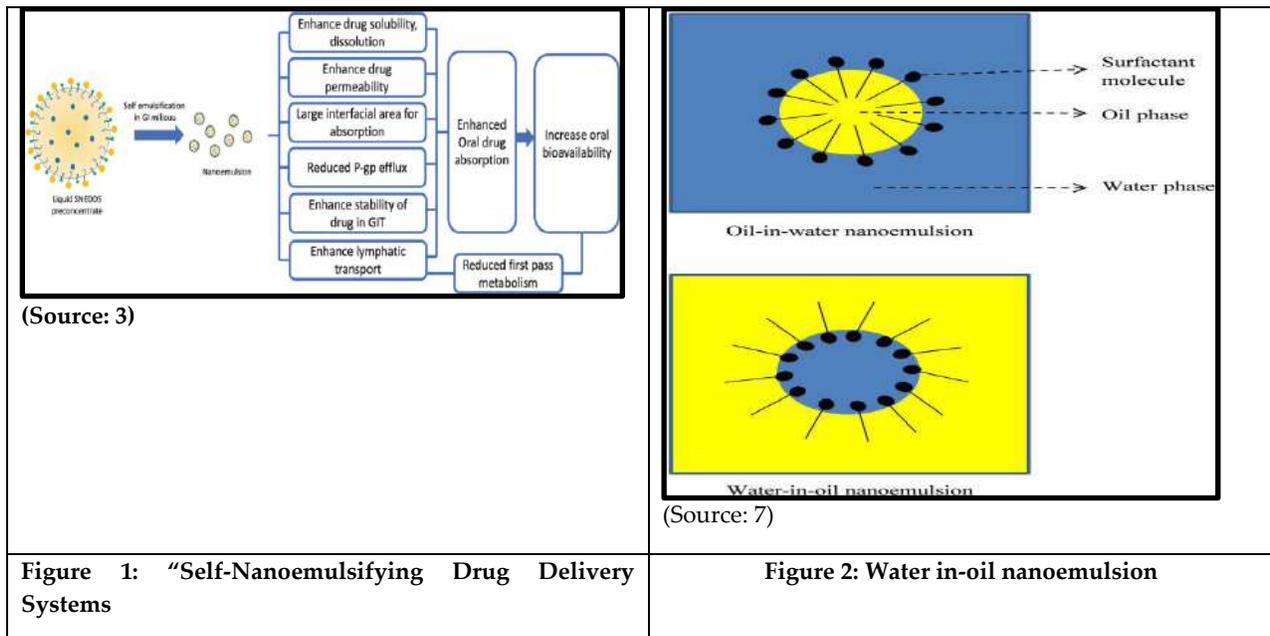
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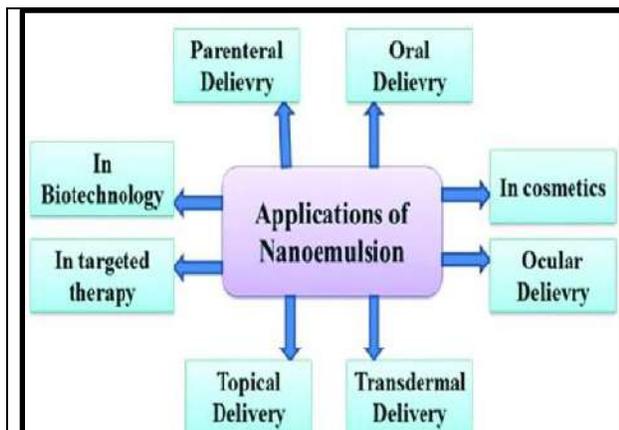
(Source: 10)

Figure 3: Application of the "Nanoemulsion"

(Source: 10)

Figure 4:Assessments of the various formulations in the system of "lipid formulation classification"
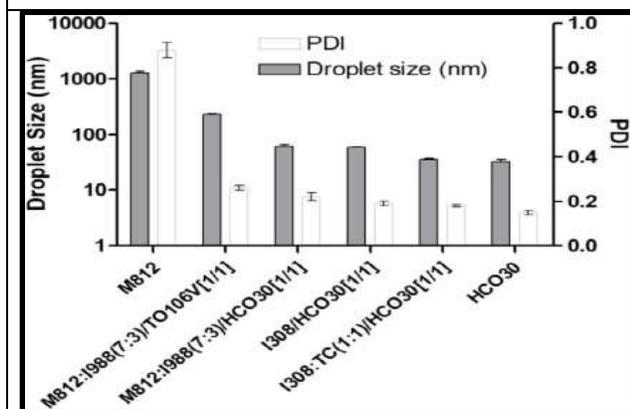
(Source: 14)

Figure 5: The consequence of the hydrophilic composition upon size of the particle as well as PDI of the lipid-based formulation.
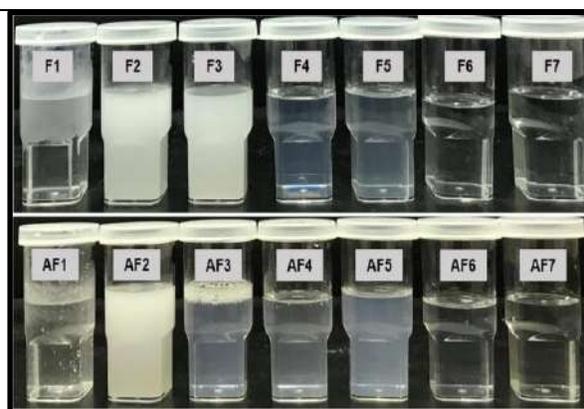
(Source: 15)

Figure 6:Physical appearance of formulation and alternative formulation after the immediate dispersion along with water

RESEARCH ARTICLE

The Role of Power Electronics in Shaping the Future of Electric Vehicles: A Comprehensive Survey

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ABSTRACT

In today's world of expanding environmental concerns and rising oil prices, the importance of and interest in EVs is growing. Electrifying the conventional transportation system can help to reduce the usage of dwindling fossil fuels while also improving performance and lowering emissions. Power electronics will be critical in developing highly efficient electric vehicles with reduced emissions and improved fuel efficiency. This study provides a detailed assessment of current power electronics technology in electric vehicles, concentrating on both semiconductor devices and material technologies. It also goes through the various power electronics systems seen in electric vehicles. The examination of anticipated future trends in power electronics technology that will enhance the markets for electric vehicles in the upcoming years finishes the study.

Keywords: Power electronics, electric vehicles, semi-conductor devices, wide band gap semiconductors

INTRODUCTION

ICE) vehicles during the first few decades of the 19th century Electric cars coexisted peacefully with traditional Internal Combustion Engine (Ilah, 2023). Due to a number of factors, including improved ICE vehicle research and development, the discovery and exploration of new oil reserves that lowered oil prices, improved ICE vehicle performance, immature EV technology, etc., the popularity of electric vehicles (EVs) has drastically decreased over the years. Due to a variety of factors, such as the harm that ICE engines caused to the environment, the steady depletion of fossil fuels that resulted in an increase in oil prices, the rise in the number of vehicles on the road that caused significant air and water pollution, etc., EVs once more attracted interest by the 1970s. There are also strict

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rules in place. Power electronics will play a significant role in the development of future energy technologies [1]. In areas like entertainment, safety, sensors for smooth operation, battery charging, etc., electronics have always been a part of the vehicle system over time. However, recent years have seen enough interest in the use of electronics in power trains for better engine propulsion and their control. It was observed that an EV's efficiency was significantly increased by switching from traditional mechanical and hydraulic systems to electric systems. This has prompted extensive research on the subject of power electrical components in electric cars. The areas where power electronics and semiconductor devices have been heavily utilized in an EV are briefly examined below.

Electric propulsion

Through several phases of power conversions, the electric supply from the source (batteries, ultra capacitors, fuel cells, etc.) is transmitted to the wheel and vice versa. This section, which is frequently referred to as the heart of EVs, has a significant amount of power electronics components. You can further divide electric propulsion into the following groups:

1. Electric sources (Batteries, ultra capacitors, fuel cells, etc., are examples of electric sources.
2. Power converters (such as inverters and DC-DC converters)
3. Transmission and Motor (DC motor, induction motor, etc.)

A battery serves as the vehicle's only power source in a BEV. The literature [3] has a study on various battery types appropriate for EV applications. The source does not contain any power electronic components; instead, it produces electricity exclusively using the electrochemical (for batteries and fuel cells) or electrostatic (for ultra-capacitors) qualities to move the vehicle. A battery has the capacity to store a lot of energy, but it's not designed to deliver a lot of power quickly. This is brought on by a poor power output density. A small amount of energy can be stored in an ultra-capacitor, but it can deliver a lot of power in a short period of time [2].

Systems for Hybrid Energy Storage in EVs

The difficulty that the majority of manufacturers encounter when choosing the source for EVs is the lack of high-specific energy and high-specific power devices that can meet all the performance requirements. For the majority of EVs, creating a hybrid energy storage system (HESS) that combines two or more storage units and modules to realize the necessary energy and power characteristics would be the best option[2]. How to connect battery and ultra-capacitor units to the DC bus presents one of the major challenges in a HESS design. For vehicular applications, which are covered in the literature [4], various converters, including Buck-Boost, Cuk, SEPIC, Half-Bridge, and Full-Bridge, may be used as the interface in HESS. Different HESS

Power converters (inverters, DC-DC converters, etc.)

Complex automotive electrical systems with many forms of energy conversion are present. An EV needs both On-Board (placed in the vehicle) and Off-Board (installed outside the vehicle, typically at charging stations and power distribution networks) power electronics. Converters are essential for operating and managing the electric motor, which drives the wheel. In essence, an electric vehicle (EV) requires a DC-DC converter, a DC-AC inverter, and an AC-DC rectifier. Figure 3 illustrates and further explores the specific applications of power electronic converters in EVs. Power electronics converters unquestionably increase the volume and weight of an EV. Therefore, the choice of any converter and its architecture should be made to reduce these characteristics without sacrificing the vehicle's performance. Plug-in Hybrid Electric Vehicles (PHEVs) are often charged using a bidirectional AC-DC converter [4]. Integrating the onboard charger with the bidirectional DC-DC converter is one way to reduce the number of switches and passive components . In order to integrate an onboard charger and a DC-DC converter with fewer switches and greater performance than current charger topologies, Dusmez et al. suggested a new interface [5]. There are various bi-directional AC-DC and bi-directional DC-DC converter topologies for EV chargers available in

Dual-direction AC-DC converters

The weight and volume of an EV are undoubtedly increased by power electronics converters. Therefore, it is important to choose any converter carefully and consider its topology in order to reduce these characteristics without

sacrificing the vehicle's performance. For plug-in hybrid electric vehicle (PHEV) charging, a bidirectional AC-DC converter is typically utilized [4]. By combining the on-board charger with the bidirectional DC-DC converter, you may cut down on switches and passive parts. A new interface that delivers greater performance in comparison to current charger topologies was proposed by Dusmez et al. for the combination of an on-board charger and a DC-DC converter with fewer switches [37]. various converter topologies for EV chargers, including bidirectional AC-DC and bidirectional DC-DC kinds.

Converters from one DC source to another

As with the back-end DC-DC converter previously described, a bi-directional DC-DC converter connects the AC-DC converter (from the onboard charger) to the energy storage unit [4]. It transforms the AC-DC converter's DC output voltage into a voltage that is adequate for charging batteries and converting battery power. based on the requirements of the system, for transmission. There are many topologies for DC-DC converters that can be found in the literature [5]. For DC-DC converters, full-bridge converters with high efficiency and a wide output voltage range are frequently used [6]. Additionally, input and output are isolated when a transformer is present, which is a benefit. The Half-bridge type converter topology, which has lower switching losses, is another often-used converter topology

Induction Motor

Traditional DC motors have been widely used in EV propulsion because of their straightforward control strategy. Due to the armature and field fluxes' intrinsic decoupling, speed, and torque control in separately excited DC motors was achievable on an individual basis. Recent technical advancements have brought about a new era for AC motors, giving them distinct advantages over DC motors like improved efficiency, higher power density, cheaper cost, more reliability, and nearly maintenance-free operation. Induction motors are the greatest option for EV propulsion, according to research on several EV motor types and their evaluations [7] Figure 4 depicts various standard electric motor types. Due to the armature and field fluxes' inherent connection, controlling AC motors like DC motors was previously not possible. However, technologies like vector control have made this possible. Additionally, ac machines completely eliminated the issues that commutator machines had. Ac induction motors are gaining popularity because they offer excellent durability and maintenance-free operation, two important factors in EV propulsion. In recent years, attention has also been drawn to the usage of Permanent Magnet (PM) motors and Switched Reluctance Motors (SRM) in EVs. Power electronics play an indirect influence in motor design because it is difficult to visually observe any power electronics components connected to electric motors. However, in the current environment, motor control without power electronics is virtually unthinkable. Schael et.'s comparison of electric vehicle power train designs using distributed induction motors revealed that the performance of the power train concept utilizing two doubly-fed induction motors is superior.

Energy Management and Their Control Methods

An effective EV design relies heavily on control. In the literature, there are numerous control methods that can be applied to EV applications. A very small amount of an energy management control method directly involves power electronics components. In order to regulate the operation of the system's available converters and equivalent power circuits, the control techniques instead use low-power analog or digital electronic systems. New applications can now be created thanks to technological developments in power electronics, and old applications can perform better as well. These developments heavily rely on the efficacy of the controls; as a result, in order to get the converter to operate as wanted and the system to function as intended, the proper control scheme must be used. Depending on a number of factors, including switching frequency, heating effects, the type of power semiconductor device being utilized, preferred architecture, etc., a suitable control strategy must be implemented. The main function of control circuits is to generate gate signals for turning on and off power semiconductor switches, detect and analyze feedback signals, control and safeguard the electrical vehicle system, etc. Control circuit creation typically makes use of contemporary microelectronic components including digital signal processors (DSPs), microprocessors, and microcontrollers. Proper software technique selection is just as important to the successful operation of EVs as choosing the right hardware.

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V. Power Semiconductor Device Version

One of the important components that affect how well hybrid electric cars (HEVs) and pure electric vehicles (EVs) function is a power-switching device. A power electronic switching device's performance is generally determined by its switching frequency, switching losses, operating temperature, range of operation (both in terms of voltage and current), and other factors. It also depends on the device technology and semiconductor material used in its fabrication. Below, both of these factors are briefly explored.

Power semiconductor switches

In converters for electric vehicles, semiconductor switches with high operating temperatures, high voltages, high powers, quick switching, and extremely low on-resistance are of utmost importance. The development of the thyristor, also known as a silicon-controlled rectifier, in the late 1950s gave rise to the solid state power electronics. Other semiconductor devices including the insulated gate bipolar transistor (IGBT), static induction transistor (SIT), and static induction thyristor (SITH) will gradually be added. It was first introduced to use MOS-controlled thyristors (MCT) and integrated gate-commutated thyristors (IGCT). Chan et al. 1996 [14] performed a comparison of EV power devices. The majority of power semiconductor switching devices on the market are silicon-based. The power devices GTO, BJT, MOSFET, IGBT, and MCT are readily available and are particularly well-suited for EV propulsion. Because it combines the conductivity of a BJT with the high input impedance and quick speed characteristics of a MOSFET, the IGBT is now the most attractive device. MOSFET and IGBT comparisons were done. Shenai . studied power devices for vehicle electronics together with their packaging and thermal considerations. Discrete power device methods and other low-power microelectronics were briefly explained. Nakayama et al. also addressed the problems with thermal management for electrical and electronic components in a vehicle environment. . Kumar et al. [8] compared power semiconductor devices for various components of an electric vehicle system.

Materials for Power Semiconductors

The material qualities of the semiconductor used to construct a power semiconductor device have an impact on both the device's performance and its capabilities[14] . Its theoretical limits of operation, including those related to higher thermal conductivity, higher breakdown strength, higher maximum operating junction temperature, higher switching frequency, etc., have forced researchers to look into newer wide band-gap semiconductor materials for production. electrical switching devices for power .Stefanskyi et al. explored the effects of semiconductor material qualities on the operation of power devices and looked at the benefits of employing silicon carbide (SiC) in power electronics. SiC is shown to have an advantage over other power semiconductor materials in the future.SiC is shown to have an advantage over other power semiconductor materials in the future . Majumdar et al. reviewed recent technologies and trends in power devices and discussed several power module technologies, concluding that the 4H-SiC MOSFET is the best switching device for future applications. Acharya et al. have presented a bidirectional DC-DC converter for PHEVs that uses SiC devices and delivers greater performance at higher operating temperatures and switching frequencies [10]. Kachi et al. investigated the automotive applications of gallium nitride (GaN) power devices and determined that while the technology currently requires significant advancement, it may one day provide an alternative. Letellier et al. [11] compared a conventional Si-based semiconductor switch to a GaN-based switch and discovered that the latter exhibits superior performance. compared SiC and GaN power electronics for automotive systems and determined that both are promising materials for upcoming HEVs and EVs. Gueguen examined the market shares and industrial trends of SiC and GaN devices and predicted a bright future for these technologies [13]. For wide band-gap power semiconductor devices, there are still issues with cost and wafer quality, steady processing, and performance reliability of the devices.

CONCLUSION

This work discusses in detail the various power electronics converters used in EVs, including as DC-DC converters, inverters, and their topologies. The numerous converter topologies and power electronic devices are also reviewed in

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the literature. With a focus on power electronics for EV propulsion, battery charging, and power accessories, this article has assessed the current state of interdisciplinary technologies in EVs. That means power electronics. The development of EVs is greatly influenced by technology. IGBTs (Insulated Gate Bipolar Transistors) are projected to fundamentally alter on-board converter technology in switching devices. IGBTs will be able to replace GTOs and enable manufacturers to create better, more affordable inverters with less harmonics thanks to three primary advantages: high switching frequency, straightforward gate control, and maybe a lack of snubber circuits. IGBT usage lowers switching losses and harmonics. Wide band-gap semiconductor materials like SiC and GaN will decrease loss in the HEV power circuit and increase overall efficiency when used as semiconductor switches[18] .

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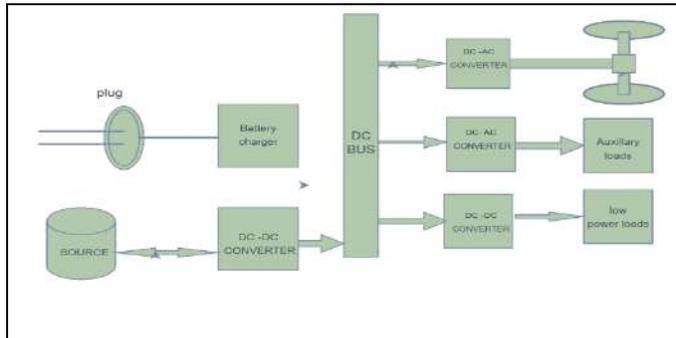
Fig.1.Role Of Power Electronics Converters In EV Applications
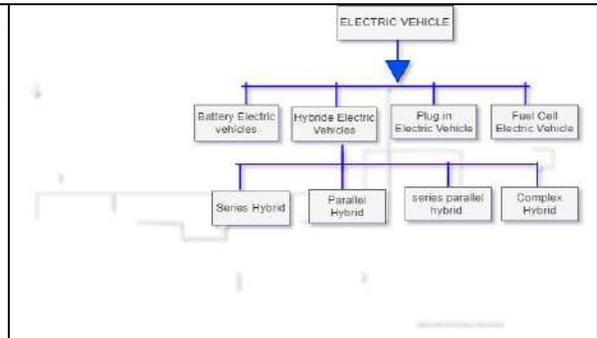
Fig .2. Broad Classification of Electric Vehicles
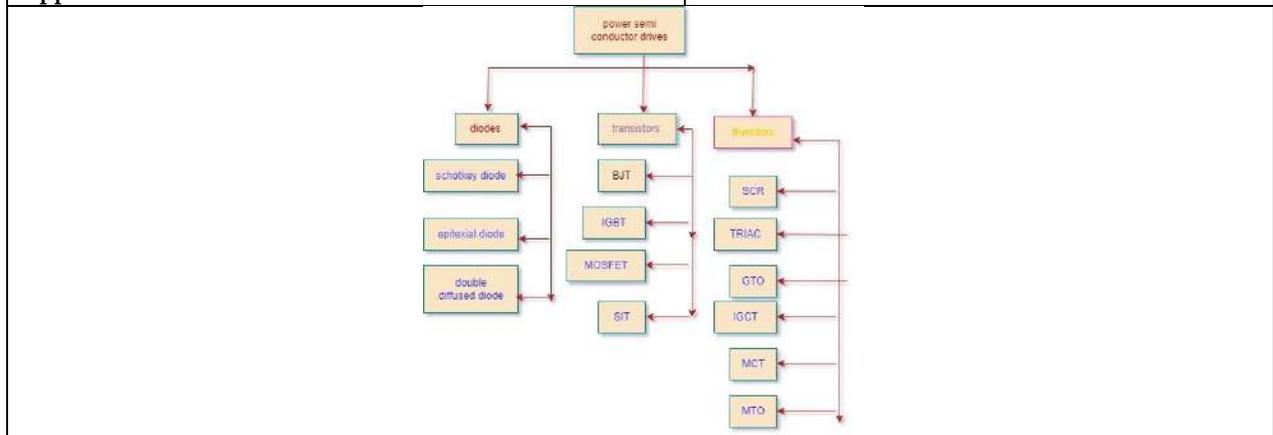
Fig .3. Classification Of Power Electronics Switching Devices

RESEARCH ARTICLE

Correlation between Body Mass Index and Renal Function Test among the Students of Assam down town University

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ABSTRACT

Obesity is the unwanted excess of body fat percentage. It is known to be the main risk factor for a number of non-communicable diseases like cardiovascular diseases, type 2 diabetes, hypertension, coronary heart diseases, or certain types of cancers. Also, Obesity is linked to an increased risk of kidney disease. A total number of 85 samples from the students of Assam downtown University were collected for this study. We measured height and weight to find the body mass index of the subject and followed by the estimation of biochemical test of renal function like serum uric acid, serum creatinine and blood urea nitrogen. In the study, it is reported that 24% were obese and 76% were overweight. Among the obese students 37% were male and 63% were female students and among the overweight 44% were male and 56 % were female students. We found that there was statistically positive correlation of BMI and renal function test. Out of 85 participants, 17 were found as high serum uric acid level, 19 were high serum creatinine level. This study can be concluded that sustaining a high BMI can alter the serum uric acid, serum creatinine and urea level.

Keywords: Body Mass Index, Obesity, Uric acid, Creatinine, Urea, Kidney disease.

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INTRODUCTION

Body mass index (BMI) is a statistical index that uses a person's weight and height to calculate body fat in males and females of any age. It is determined by dividing a person's weight in kilogrammes by their height in metres squared. This equation's output is then used to calculate an individual's BMI [1]. The National Institute of Health (NIH) now classifies individuals as underweight (BMI <18.5 kg/m2), normal weight (BMI 18.5 to 24.9 kg/m2), overweight (BMI 25 to 29.9 kg/m2), or obese (BMI ≥30 kg/m2) [2].

BMI and Obesity/Overweight
Obesity and overweight are defined as abnormal or excessive accumulation of fat that can be harmful to health. Body mass index (BMI) is recommended by the World Health Organization (WHO) to classify obesity and is used as a tool to identify patients or individuals at risk for adverse health outcomes [3]. According to the WHO (2022), Obesity affects more than one billion people worldwide, including 650 million adults, 340 million adolescents, and 39 million children. WHO estimates that by 2025, approximately 167 million people will be less healthy as a result of being overweight or obese. [4]. The risk factors of obesity/ overweight include lack of physical activity,unhealthy eating behaviours, not getting enough good-quality sleep, high amounts of stress, genetics, use of medicines like Antidepressants, Antipsychotics, Beta-blockers etc[5].

Kidney Diseases and Obesity/Overweight
Obesity is a serious health issue that has a negative impact on all body systems, particularly the cardiovascular and endocrine systems [6]. Kidney problems have recently begun to attract more attention as one of the negative consequences of obesity. With increased obesity prevalence over the last 30 years, there has been a significant increase in the prevalence of chronic kidney disease and end-stage renal failure [7]. The kidney is responsible for the elimination of 70% of the daily uric acid production. However, in recent years it has been suggested that uric acid itself plays a causal role in the pathophysiology of chronic kidney disease and possibly acute kidney injury [8]. Creatine is a nitrogenous organic acid that is generated predominantly in the kidney and liver and it is the end product of creatine and creatine phosphate metabolism [9]. It is widely accepted that serum creatinine is excreted mainly by the kidney, in the setting of kidney insufficiency, creatinine appears to have an altered rate of production and alternative routes for degradation and elimination [10]. Serum creatinine is the most commonly used biomarker of kidney function [11]. Increased serum creatinine and/or blood urea nitrogen (BUN) levels, as well as decreased urine output, can be used to diagnose kidney function. Changes in BUN and serum creatinine may indicate not only renal injury, but also normal kidney responses to extracellular volume depletion or decreased renal blood flow [12]. Obesity/overweight is associated with an increase of BUN [13].

MATERIALS AND METHODS

Study Area A prospective study was carried out in the Department of Medical Laboratory Technology, Assam down town University, Guwahati, Assam. Ethical clearance for this study was obtained from the ethical clearance committee of Assam downtown University **(Memo No.: AdtU/Ethics/stdnt-lett/2023/011)**.

Study Subjects In this study, 85 randomly selected subjects who were normal, overweight, or obese by measuring their BMI level were selected. BMI= Weight (Kg)/ Height² (m²).

A questionnaire was used to collect the data and information about the subjects, which includes name, age, sex, and lifestyle, use of tobacco and alcohol, and health disorders like hypertension, cardiovascular diseases, gout, and arthritis.

Inclusive criteria
- Students having a higher BMI than normal.
- Students who were above age of 17 years.

Exclusive criteria

- Students having a lower BMIthan normal and below the age of 17 years.
- Students having hypertension, cardiovascular diseases, gout, arthritis.

Method of Sample Collection

Blood sample of 5ml from the median cubital vein was collected in a plain vial.

Biochemical Estimation

Estimation of Uric acid by Enzymatic Uricase PAP method according to Prietest clinical chemistry reagent, ROBONIK (INDIA) Pvt. Ltd. Serum creatinine by kinetic test without deproteinization according to the jeff method, ROBONIK (INDIA) Pvt. Ltd. Blood Urea Nitrogen (BUN) by Photometric test Enzymatic according to modified Berthelot, ROBONIK (INDIA) Pvt. Ltd.

Statistical Analysis

All the Statistical analyses were done using GraphPad Prism 9.5.1 (GraphPad Prism Inc., San Diego, CA). One-way analysis of variance (ANOVA) and the t-test were used to determine the significance of differences and comparisons between the different study populations.

RESULT AND DISCUSSION

Body Mass Index (BMI)

A person is considered as obese if he has a body mass index of 25kg/m2 or higher that accumulates excessive unwanted body fat and increases the risk of several health problems such as heart disease, diabetes, high blood pressure, and several types of cancer [14]. In our study **(Fig.1 and Table No. 1)**, we have classified the individuals as overweight or obese according to their BMI. Our findings reported that the prevalence of overweight was 76% and that of obesity was 24%. Among the obese, 37% of the subjects were male and 63% were female. Again, among the overweight, 44% were male and 56% were female **(Table No. 2)**. Women are more likely than men to be overweight or obese. Karnik *et al*. [15] reported similar findings in their previous study.

Renal Function Test and BMI

Serum Uric Acid Level

In this study, the data in **Fig. 2** reported that there was no statistically significant difference in the uric acid level of overweight and obese subjects compared to controls when the significance level was set @ <0.05, p = 0.6740 and p = 0.3657, respectively. Though no significant changes were observed, there was a gradual increase of 9.67% in overweight and 17.27% in obese when compared to the control group. A similar finding was reported in a previous study[16].

Serum Creatinine Level

Data summarized in **Fig. 3** showed no significant change in serum creatinine levels in overweight and obese individuals when compared with the control group. The significance level is set @ < 0.05, p = 0.5578, and p = 0.1423, respectively. This study reported a gradual increase of 12.74% in overweight and 27.85% in obese when compared to the control group. A similar finding was reported by Salman, D *et al* [17]. Another previous study, Akkasilpa *et al* [18], reported similar findings.

Blood Urea Nitrogen

Again, the data in **Fig. 4** reported that there was no significant change in the BUN of overweight and obese individuals when compared with the control group. Though there was a marginal decrease of 6.20% in overweight and 5% in obese when compared to the control group, the significance level is set @ < 0.05, p = 0.5271, and p = 0.6347, respectively.

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Correlation between BMI and Renal Function tests

In **Table No. 3**, we also analysed the data to look at the correlation between BMI and serum uric acid in this group of subjects. It was found to be positively correlated; the significance level is set @ < 0.05 (p = 0.2308 and r = 0.1313). A similar study previously reported that the overproduction and secretion of uric acid in subjects with obesity and reduced clearance of uric acid through the urinary tract were also observed in subjects with obesity [19]. According to this study, the correlation between the BMI and serum creatinine level was observed as statistically significant with a positive correlation; the significance level is set @ < 0.05 (p = 0.0356* r = 0.2282). A similar finding was reported by Quinones *et al*. and Wingrove *et al*. [20] [21]. Again, a positive correlation was observed between BMI and serum urea level; the significance level is set @ < 0.05 (p = 0.5644, r = 0.06338). The main finding of this study is that subjects in the study population with a higher BMI were likely to have a risk factor for kidney damage, as this is positively correlated with serum uric acid, serum creatinine, and serum urea levels. Similarly, the same finding was demonstrated by a previous study [22].

CONCLUSION

This study shows that high BMI is associated with impaired kidney function, not vice versa. Individuals with overweight or obesity should be more aware of the risk of developing renal dysfunction and other non-communicable diseases such as diabetes, hypertension, coronary heart disease, strokes, etc. From the findings of this study, it can be concluded that sustaining a high BMI can alter serum uric acid, serum creatinine, and BUN levels, and hence determining BMI can potentially be used as a novel clinical indicator for identifying patients at high risk of hyperuricemia or renal dysfunction. Further studies can be done for a more accurate evaluation, as this study has limitations due to its small sample size.

ACKNOWLEDGEMENT

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Table 1. Gender specific anthropometric variables among students of Assam downtown University.

	Mean		
	Weight	**Height**	**BMI**
Female (n=48)	68.85 ± 10.07 Kg	1.555 ± 0.0533 m	28.38 ± 3.355
Male (n=37)	78.24 ± 9.465 Kg	1.674± 0.0740 m	27.89 ± 3.314

Data are expressed as Mean ± SD

Table 2. Prevalence of overweight and obesity among the students of the   Assam downtown University.

	Male	**Female**
Obese	7(37%)	12 (63%)
Overweight	26(44%)	33 (56%)

Data are expressed as percentage.

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Table 3. Correlation between BMI with uric acid, creatinine and urea.

	Uric acid		Creatinine		Urea	
	r	**p**	**r**	**p**	**r**	**P**
BMI	0.1313	0.2308	0.2282	0.0356*	0.06338	0.5644

Data are expressed as Mean ± SD, significance level was fixed at $p < 0.05$.
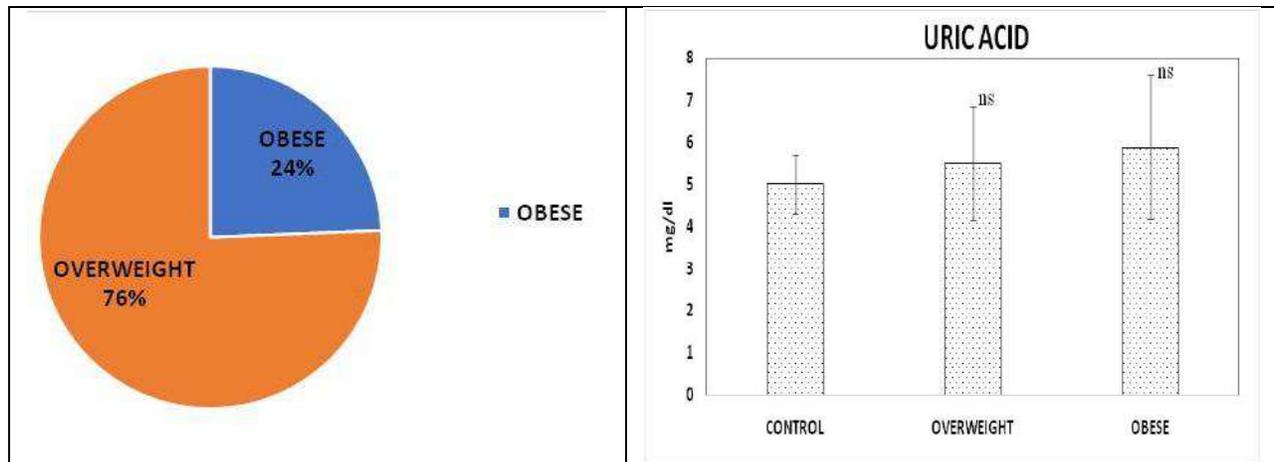
Figure 1: Prevalence of overweight and obesity among the students of Assam downtown University.

Figure 2: Uric acid level of the students of Assam downtown university.
Data are expressed as Mean ± SD, significance level was fixed at "*" $p < 0.05$
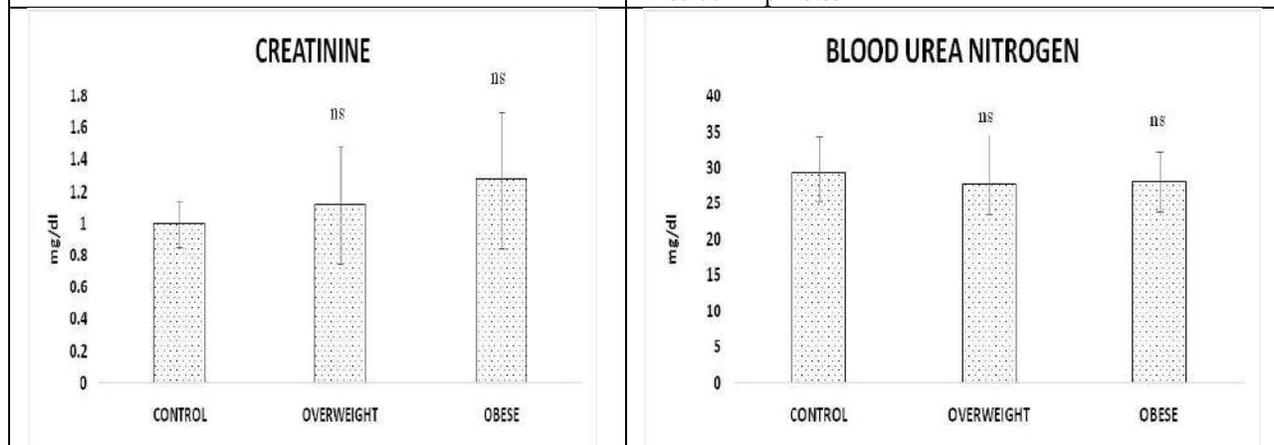
Figure 3: Creatinine level of students of Assam downtown University.
Data are expressed as Mean ± SD, significance level was fixed at $p < 0.05$.

Figure 4: Urea level of students of Assam downtown University.
Data are expressed as Mean ± SD, significance level was fixed at $p < 0.05$.

RESEARCH ARTICLE

A GIS-based Analytical Hierarchy Process was Employed to Conduct an Assessment of Potential Groundwater Zones in the Kuzhithuraiyar Sub Basin

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ABSTRACT

Groundwater (GW) is the sustainable source of fresh water. GW constitutes about 30% of the world's fresh water. There are a number of factors, including population growth, urbanization, and industrialization, that pose a significant threat to GW sources. Both the amount and nature of GW sources are altogether affected by environmental change. This study has also emphasized the necessity of employing sustainable water management strategies to ensure the long-term viability of GW resources for irrigation. With the identified prospective zones serving as critical sources of irrigation water. Integrating these water-saving methods into agricultural practices can boost crop yields while reducing overall impact on GW resources in this sub-basin. Furthermore, the factors influencing GW re-energize are altogether affected by environmental changeability. The groundwater possible zone (GPZ), which can be utilized to enhance the GW supply, should thusly be distinguished and characterized. The research is carried out in the Kuzhithurayar sub-basin of the Kanyakumari district. In this area, GW, as opposed to surface water, serves as the primary source of water for agricultural and residential uses. Numerous factors, such as geology, DEM, lineament density, geomorphology, soil, slope, drainage density, rainfall, LULC, and aspects, are generated as distinct layers in the GIS background in order to identify potential GW zones. The weighted overlay analysis of these layers follows. The analytical hierarchy method and the multi-criteria decision-making technique, which enables pairwise evaluation of the criteria affecting

the potential zone, were used to establish the weights for the various layers. The GW Potential guide has also been divided into five categories: extremely high, high, moderate, low, and extremely low. According to the study's findings, the very high potential zone accounts for 25.68 percent of total land area (90.295 km2), the high 24.18 percent of total land area (85.004 km2), the moderate 21.11 percent of total land area (70.713 km2), the low 18.05 percent of total land area (63.422 km2), and the very low 11.98 percent of total land area (42.130 km2). Moreover, it was found that the outcomes had areas of strength for a with well yield information as well as pre-and post-rainstorm water level information. Future management plans, including natural and artificial recharge practices, can be efficiently formed in these locations because the methods used produced reliable results.

Keywords: Groundwater potential zone (GPZ), Geographic information systems, Weighted overlay, Analytical hierarchy process (AHP) and Kuzhithuraiyar sub basin

INTRODUCTION

For every living thing, water is a gift. In a nation like India, where agriculture accounts for a significant portion of the economy, water is essential to development. In addition to the residential and irrigation industries, its use benefits the majority of businesses. Surface-obtained water should be treated before utilization, yet GW is significant for its new newness. India has a potential water supply of commonly 1999.20 billion cubic meters (BCM), which normally streams into the streams. It makes up slightly more than 4% of the world's river water. In any case, something like 1123 BCM of the all-out yearly water potential can be used productively in light of the fact that to various geographical limits and lopsided dissemination over existence. 433 BCM of GW and 690 BCM of usable surface water can be used to accomplish this CWC, 2022.

According to (Reddy *et al.*, 1996) GW is used by nearly 30% of the urban population and more than 90% of the rural population in India for drinking and domestic purposes. GW is bound to happen because of the collaboration of climatic, land, hydrological, organic, and physiographic factors than by some coincidence (Arkoprovo et al., 2012).As a result, increased consumption leads to overexploitation of various water sources, which in turn results in a water shortage. Individuals began using GW assets since surface water assets were turning out to be scant and contaminated (Bharti et al., 2011). By properly managing its use and preventing contamination, GW's continued importance as a component of ecosystems and human activities can be ensured. The rate at which GW flows is determined by the rock's porosity and permeability. Pumping, evaporation, and wastewater seepage into streams and lakes are the primary causes of GW discharge. The essential wellsprings of GW re-energize are precipitation and stream. Roughly 33% of the total populace is projected to drink GW. (Jose et al., 2012).

The Dumka district of Jharkhand, India, uses an integrated strategy of RS, GIS, and AHP method to determine GW potential zones. The GW potential zones were defined using a variety of data sets, including lithology, lineament density, geomorphology, slope, soil, rainfall, drainage density, and land use/land cover (Murmu *et al.*, 2019). All of the aforementioned criteria were constructed as spatially distributed maps or thematic layers in a GIS environment utilising both ground and remotely sensed data. This study provides a convenient method for delineating the potential availability of GW resources, which will ultimately aid in better GW resource planning and management. Geographical Information System (GIS) and remote detection are useful tools for characterizing potential GW zones. The extensive use of satellite data, conventional maps, and corrected ground truth data in recent years has made developing the baseline data for GPZ easier (Chowdhury *et al.*, 2010). As well as giving a wide reach size of the space-time scattering of perceptions, remote detecting likewise assists set aside with timing and cash (Tweed *et al.*, 2007). Many researchers around the world have used remote sensing (RS) and geographic information systems (GIS)

to investigate potential GPZ. They discovered that the elements used to define the zones varied, which explains why the results varied (Teeuw *et al*., 1995).

(Subbarayan *et al*., 2020) the Gundihalla watershed in Karnataka's Bellary district's hard rock region was identified as the GPZ. Pre- and post-monsoon groundwater fluctuation data, as well as geomorphology, lithology, LULC, soil, drainage density, lineament density, rainfall, and slope, were used to validate the results. Put together groundwater investigation just with respect to lineaments, while others consolidated lineaments with different boundaries, for example, seepage thickness, geomorphology, geography, slant, land use, precipitation power, and soil surface (Ganapuram *et al*., 2008). The logical pecking order method and GIS have been joined to direct a few explorations on this setting all through the world. It is preferable to use a combination of technical and expert methods to calculate weights rather than assigning them at random, as the study takes a variety of influencing factors into account. According to (Gupta *et al*., 2018) AHP was found to be an effective method for deciding on solutions to problems involving multiple criteria.

The integration of RS and GIS will make identifying potential GW zones easier by preparing several thematic layers with weighted spatial domains for lithology, drainage density, lineament density, rainfall, slope, soil, and land use (Magesh *et al.,* 2012) and (Pandey et al., 2015). To design, use, make due, and direct GW assets, the current study centres around the recognizable proof of GW possible zones in the Kuzhithurayar subbasin of the Kanyakumari area, Tamil Nadu. By identifying the drilling sites and man-made reservoirs that are required for the replenishment of GW resources, the study hopes to provide policymakers and decision-makers with useful data for sustainable GW management. The current study is essential for the administrative staff to better manage the socioeconomic aspects of GW resources because no similar studies have been reported in the study area to date.

Study Area

The greater Kodayar River Basin, which is located in India's Kanyakumari district of Tamil Nadu, includes the Kuzhithuraiyar Subbasin. Kuzhithuraiyar is one of the numerous subbasins of the Kodayar River, a significant river in the region. The 351.564 square kilometers of the Kuzhithuraiyar subbasin are the primary focus of this investigation. The Kuzhithuraiyar sub bowl will probably be situated between scopes 77°05' and 77°23' East and longitudes 8°11' and 8°26' North. The Kanyakumari Locale's regulatory boundaries basically encompass the entire basin. The Kodayar basin includes the Kuzhithuraiyar subbasin. The Kuzhithuraiyar subbasin of the Kodaiyar basin has the highest population density (2230 inhabitants per square kilometer). This is the second-biggest Sub-bowl of the Kodaiyar Bowl. Subsequent to starting in the Western Ghats and streaming west through the Kanyakumari district, the channel discharges into the Middle Eastern Ocean close to Thengapattinam. The main drainage basin in Tamil Nadu is connected to the discharge from the Arabian Sea. GW is crucial for supporting crop irrigation in the Kuzhithuraiyar subbasin, which is primarily an agricultural region. Ranchers depend on GW wells and cylinder wells to enhance precipitation for supported farming creation, particularly during droughts or when surface water sources are deficient. The geography of the Kuzhithuraiyar subbasin in Kanyakumari region can be depicted as a mix of uneven territory and waterfront fields. The study area's location is depicted in Fig. 1.

MATERIALS AND METHODS

The Kuzhithuraiyar Subbasin was the focal point of the review, which incorporated the appraisal of GPZ utilizing numerous datasets and consecutive methodologies. The objective of the current examination study was to foster a scientific ordered progression process AHP model utilizing remote detecting, geographic data frameworks, and cartographic techniques with ArcGIS 10.8.1 as displayed in Fig. 2.

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Thematic Layer Preparation

Ten distinct topical layers, which could incorporate DEM, Geography, lineament thickness, geomorphology, soil, slant, waste thickness, precipitation, LULC, and Angles, have been created utilizing remote detecting and traditional/existing information with the guide of ArcGIS 10.8 programming for the evaluation of GW possible zones. The geomorphological features and lines were identified using Landsat 8 (30-m resolution) imagery downloaded from the US Geological Survey's Earth Explorer website (www.earthexplorer.usgs.gov). To recognize the geomorphological landforms and lineaments, the bogus variety composite (FCC) picture was outwardly assessed utilizing picture translation keys such as shape, size, tone, surface, example, and affiliation. Digital Elevation Model (DEM) data with a resolution of 30 meters were used to create the study area's slope and drainage pattern using the USGS Earth Explorer https: Earth Explorer https://earthexplrer.usgs.gov// earthexplrer.usgs .gov/was utilized to extricate the seepage design, and the line thickness apparatus in ArcGIS was utilized to make guides of waste thickness and lineament thickness from DEM. The computerized soil guide of the planet was downloaded in vector design from https://www.fao.org/. Utilizing the Opposite Distance Weighted (IDW) spatial addition strategy in ArcGIS, Indian Meteorological Division (IMD) https://www.imdpune.gov.in/Establishment of water studies (IWS) to gauge the typical complete yearly precipitation in view of 30 years (1991-2020) of information of 4-point areas. All subject layers were delivered, changed over completely to raster design, projected to UTM Projection, Zone 44 Northern, Datum WGS 84, and given a 30-m spatial goal.

Assignments of weight and weights normalization using AHP

The weighting of each class is the most important step in an integrated analysis because it determines how accurate the result is (Muralitharan and Palanivel, 2015). Index models, frequency ratio (FR), certainty factor (CF), weights-of-evidence (WOE), fuzzy logic, and multi-influencing factor (MIF) are all weight-calculating methods have been used to define the GPZ. One of these methods, analytical hierarchy process (AHP), is emerging as a leader in GW prediction modelling and has the potential to provide findings quickly, accurately, and at an affordable cost. The mathematical mean and standardized load of a solitary boundary are figured utilizing an AHP strategy, which is a couple wise lattice scientific technique (Chowdhury *et al.*, 2009; Jha *et al.*, 2010; Kaliraj and other, 2014). As per Saaty (1990), it produces relative proportion scales for matched examination Table 2. The current investigation utilized Saaty's (1980, 1990) AHP strategy. It is used to make decisions about the final weights that will be given to various thematic layers and the attributes that go with them. The first steps of the AHP technique are used to organize the problem into a hierarchy by defining the purpose of the problem and determining the criteria and sub-criteria that are most important to the occurrence of GW (Muralitharan & Palanivel, 2015). According to Saaty (1990), one advantage of hierarchy is that it enables us to concentrate our judgment on specific aspects of a number of attributes, each of which is necessary for making a sound decision.

Assessment of Groundwater Potential Zones

According to Kumar and Krishna (2018), the Groundwater Potential Index (GWPI) is a dimensionless variable that promotes in determining the existence of GPZ. To detect feasible GW zones, the weighted linear combination approach was utilized. According to Muralitharan and Palanivel (2015), the Total Scores (TS) were calculated by adding the products of all the attributes and then multiplying the weights of the thematic layers by the weights of the features within each thematic layer:

$$TS = \sum W \times R \qquad (1)$$

where TS is short for "Total Score," W is short for "Thematic Layer Weights," and R is short for "Feature Layer Weights." Utilizing the correlation lattice between the other options and the information on the positioning of the rules, AHP gives a general positioning of the arrangements Table 2. According to Muralitharan and Palanivel (2015), the most important choice is the one made. Concurring on the leader's pairwise examinations of the assessment rules, the AHP makes a load for every evaluation measure. The consistency ratio's accuracy has been confirmed. The following equation would be used to verify the table's consistency ratio:

$$CR = CI/RI \qquad (2)$$

Where CI is Consistency Index and

RI is Random Index

CI = λmax-n/n-1

Where λmax is the principle eigen value and n is the no. of comparisons

Groundwater Potential Index

As thematic layers, each of the aforementioned parameters was created. In addition, its weight and ranking are determined by the nature of its influence. Using the AHP Technique, weights have been assigned. Priorities determine the ranking. The weighted and ranked layers of Arc GIS 10.8 Software were incorporated into the GIS environment. Table 5 provided the weighting and ranking information.

GW Potential index can be calculated as follows

GWPI= $(W_r \times R_r) + (W_e \times R_e) + (W_s \times R_s) + (W_g \times R_g) + (W_{lu} \times R_{lu}) + (W_{dd} \times R_{dd}) + (W_{gm} \times R_{gm}) + (W_{ld} \times R_{ld}) + (W_{st} \times R_{st}) + (W_a \times R_a)$

Where,

W – Weightage

R- Rank

r- Rainfall

e - Elevation

s - Slope

g - Geology

lu- Land use Land cover

dd- Drainage Density

gm – Geomorphology

ld – Lineament Density

st- Soil Type

a - Aspects

Groundwater potential zones can be delineated from the calculated potential Index. According to its sum-up values, the added Potential index can be classified into four categories: excellent, beneficial mild, poor, and very poor.

RESULTS AND DISCUSSIONS

The Kuzhithuraiyar sub-basin's groundwater potential zones have been assessed using GIS-based AHP, which has produced illuminating results that fully comprehend the groundwater potential's spatial distribution. The groundwater potential map produced by the AHP analysis included high, moderate, and low potential zones based on lithology, land use, slope, rainfall, soil properties, and drainage proximity. High potential zones coincide with naturally occurring vegetation and permeable geological formations, which improves recharge. By using the right techniques, moderate zones with moderate permeability, mixed land use, and intermediate slopes provide opportunities for sustainable extraction. Urbanization and impermeable lithology are indicators of low potential zones, which call for cautious exploitation. The reliability of the AHP-based approach was confirmed by field validation. Planning for resources, prioritizing sustainable development, promoting favourable land use policies, and recognizing constraints are all influenced by the results. This section presents the key findings and discusses their implications for sustainable groundwater resource management. Table 5 depicts the thematic layers with class influences and weighting clearly.

Digital Elevation Model (DEM)

An advanced rise model (DEM) is a computerized representation of the height of the ground surface for any upward datum. A DEM is a computer-generated representation of a geographical surface. Table 5 and Fig. 3. The most basic type of digital topographic representation is a DEM (Sudalaimuthu, K *et al.*, 2022). In terms of the overall direction of GW flow and its impact on GW recharge and discharge, elevation is related to relief setting at the local and regional levels.

Lineament Density

Lineaments go about as a channel for the progression of spillover into underground springs. These are the bent or straight shapes that arose as a statement of geographical highlights like creases, cracks or blames that are subsurface. These lineaments in satellite information by and large show linearity and curvilinear associations with vegetation, seepage, soil resonances, and alleviation as investigated by (Manimaran et al., 2013).

Lineaments are direct or curvilinear bigger breaks or blame that are primarily controlled. The auxiliary porosity for water permeation is given by the lineaments. The all-out length of lineament crossing per unit region is utilized to register lineament thickness. The opportunities for GW are expanded when the lineament thickness is higher has been displayed in Fig. 4.

Geomorphology:

One of the main factors influencing the GW potential is geomorphology. Geomorphology, the scientific study of landforms, includes all aspects of landforms, including their origins and development, the processes that create them, and the materials that they eventually deposit. This study takes a gander at scenes to find how air, water, and ice could influence the landscape. These processes on the earth's surface, which transport and deposit rock and sediment in a variety of locations before eroding it, result in the formation of landforms. Geomorphology is an important factor in determining GPZ. (Palaka et al., 2015; Rajasekhar et al., 2022)Fig. 5 and Table 5 of the geomorphological map of the research area were downloaded from the Bhukoash website; they should be clipped using the ArcGIS 10.8. software's extracting tool. It is separated into five layers: the Pediment Pedi plain, which includes water bodies and a river as well as Dissected Hills and Valleys, Coastal Hills and Valleys, and more. The majority of the study area is occupied by the Pediment Pedi plain, followed by water bodies and rivers, dissected hills and valleys, and coastal hills, and valleys. The landforms and water retention capacity of each layer are used to rank them.

Soil

Soil texture has a big impact on surface runoff and GW recharge. (Jasrotia *et al.,* 2016), GW re-energize is impacted by soil types, penetration rates, permeation rates, and penetrability. Fig. 6 depicts the five types of soil that make up the majority of the research area: Clay, Sandy Clay Loam, Sandy Loam, Clayey Sand, and Sand.

Slope

The accessibility and re-energize states of GW in a specific area are profoundly subject to a slant. As per (Dawoud *et al.,* 2005), (Vittala *et al.,* 2005), Solomon and Quiel (2006), the slant is communicated in degrees. As per slant, the locale is partitioned into five classifications: Table 5 includes very steep, steep, moderately steep, moderately sloping, and gentle slopes. Since they are thought to have good potential, gentle slopes received the highest score of 5 points. Extremely steep slants with significant degrees of surface spillover are remembered to have restricted GW potential, and the most minimal score of 1 was given in Fig. 7.

Drainage Density

Any territory's waste example uncovers both the surface elements and the underground designs. This characteristic is recognized by the underlying lithology, which is a key indicator of the pace at which water percolates (Shaban *et al.*, 2006). Seepage thickness is a converse capability of porousness, so it is a significant boundary in assessing the GW zone. When compared to zones with low drainage densities, high drainage densities indicate less infiltration and, as a result, serve as poor GW potential zones—implying an opposite relationship between the two. A low organization of waste course demonstrates the presence of exceptionally safe and porous stone while a high seepage course shows profoundly feeble and impermeable rocks (Karanth 1999). Low drainage density zones received a higher rank for GW prospecting, while high drainage density zones received a lower rank. Fig. 8 shows that the drainage density of the entire study area ranges from 1 to 290 km/km^2.

Rainfall

Rainfall is the primary source of water for runoff above the surface of the earth, which floods lowland areas. Runoff occurs when rainfall is greater than the soil's (soil and articulated weathered rock) capacity to absorb it. GW assets are essentially re-energized by precipitation. Precipitation in the district comes from both the upper east and Southwest storms. For this study, Rangarajan *et al*. used data from the Indian Meteorological Department (IMD) to create the rainfall map. After that, the data were imported into a GIS system, and a method of spatial interpolation known as IDW was used to create a map of rainfall. The area's precipitation is separated into five classifications to rank. There are five different kinds. Extremely low to high Fig. 9, as a matter of fact. The rainfall data for the 30 years (1991-2020) were generated using the mean monthly data from four rain gauge stations in the research area. The four distinct seasons of pre-monsoon, southwest monsoon, northeast monsoon, and post-monsoon were discovered after analysis. Maps of the spatial distribution for each of the four seasons were created using ArcGIS. The pattern of the rain was determined using this rainfall data. The locale gets a normal of 1456.78 mm of precipitation every year, with the post-storm, pre-rainstorm, southwest rainstorm, and upper east rainstorm each contributing 32.87 mm, 335.28 mm, 538.67 mm, and 549.97 mm, separately.

Land Use/ Land Cover (LULC)

Using land cover data, one can calculate the proportion of a given area that is made up of different types of land and water, such as forests, wetlands, impermeable surfaces, agricultural land, and other types of land and water. There are two types of water: open water and wetlands. Displays how people use the landscape for development, conservation, or a combination of the two. The land sat 30 m global land cover time dataset (Karra, K., *et al*.) was used to create land use and land cover. Fig. 10 and Table 6 depict the area use/landcover attributes that are available in the examination district.

Aspects

Due to its overall effects on adjacent soil water balances, the slope affects the amount of water available for infiltration (Mallick *et al*., 2021). Aspect is a crucial topography feature that has an impact on a basin's capacity for GW recharge. It is the slope's direction, typically measured in the clockwise direction from 0 to 360 degrees. Zero, 90, 180, and 270 are the angles that point north, south, and west, respectively. Development of drainage basins and slope exposure orientation influence microclimatic variations in arid and semi-arid environments. Perspective so straightforwardly influences the microclimates (Hadley 1961). A viewpoint guide of the review region is displayed in Fig. 11. North (0 – 22.50), Northeast (22.50 – 67.50), East (67.50 – 112.50), Southeast (112.50 – 157.50), South (157.50 – 202.50), Southwest (202.50 – 247.50), West (247.50 – 292.50), and Northeast (292.50 – 337.50) are the four directions in which the aspect of the Kuzhithuraiyar subbasin is trending.

Geology

GW dispersion and events are essentially affected by an area's land structure, as is notable (Krishnamurthy and Srinivas, 1995). Geography had given the loads close to lineament thickness, as a result of their porousness and invasion limit. Concerning the concentration in Tiruttani by (Kolandhavel and Ramamoorthy 2019). The geography of the review region was digitized from the toposheet and was sorted into five primary gatherings say Charnockite gneissic, Khondalite, Migmattie, Late Cretaceous and Warkali which are displayed in Fig. 12

Groundwater Potential Zone

The weighted overlay techniques in the IDW method's spatial analysis tool were used to overlay the cumulative weights assigned to each of the thematic layers (Geology, DEM, lineament density, geomorphology, soil, slope, drainage density, rainfall, LULC, and Aspects) to create the GPZ map. During the weighted overlay analysis process, each theme layer was given a ranking and weighting based on how much water it might contain. Higher and lower weights were doled out, individually, to GW with high and low potential. In the wake of positioning and weighting each layer, the amount of those values was ordered into a forthcoming GW zone. After rasterizing each layer, it was combined. The review region was separated into five classes (Table 7) in light of weighted overlay examination: generally excellent (25.68%), great (24.18%), moderate (20.11%), poor (18.05%), and exceptionally poor (11.98%).

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That's what the outcomes show, with an all-out area of 351.564 km², most of the district is classed as an excellent likely zone (90.295 km²), great possible zone (85.004Km²) trailed by a moderate (70.713 km²), low (63.422 km²), and poor (42.130 km²) expected zone. Fig. 13 depicts the potential zone on the GW map.

CONCLUSION

The current study focused on a probabilistic strategy that used both GIS and RS satellite imageries to identify potential GW zones in the Kanyakumari District, Tamil Nadu, India's Kuzhithuraiyar Sub-basin. The identification of GW zones is frequently required as the population and development grow. Because of the surface water of the Kuzhithuraiyar River, agricultural activity in the study area is dependent on GW. Its purpose was to identify which GPZs could be useful for household and irrigation purposes. The potential of GW in distinct zones is shown by the spatial distribution of the area's water levels. The Kuzhithuraiyar Sub-bowl GW potential area has been reviewed as awesome (25.68%), great (24.18%), moderate (20.11%), low (18.05%), and poor (11.98%) in view of the joined weighted topical outlines. Artificial recharge operations in low and poor potential zones, as well as GW prospecting and resource development, will benefit from these newly discovered GW potential zones. The study concluded that gathering rainfall and runoff from surplus to deficit areas can be used to regulate sources. Based on the study's findings, concerned decision-makers can devise an effective GW management strategy for the research area. The GIS-based AHP used in this study provides a solid approach for evaluating GPZ and informing effective decision-making for long-term water resource management. This research contributes to a better understanding of GW availability, vulnerability, and utilization in the Kuzhithuraiyar sub-basin, laying the groundwork for prudent water management practices and protecting this vital resource for current and future generations.

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Table 1 Pairwise Comparison matrix of Influencing Parameters

Factors	Rainfall	Elevation	Slope	Geology	LULC	Drainage density	Geomorphology	Lineament Density	Soil type	Aspect
Rainfall	1	3	3	1	1	3	1	3	1	1
Elevation	0.3	1	5	1	1	3	1	3	1	1
Slope	0.3	0.5	1	1	3	3	0.2	3	1	1
Geology	1	1	1	1	1	1	3	3	1	1
LULC	1	1	0.3	1	1	1	1	1	1	1
Drainage density	0.3	0.3	0.3	1	1	1	1	1	1	1
Geomorphology	1	1	2	0.3	1	1	1	1	1	1
Lineament Density	0.3	0.3	0.3	0.3	1	1	1	1	1	1
Soil type	1	1	1	1	1	1	1	1	1	1
Aspect	1	1	1	1	1	1	1	1	1	1

Table 2 Pair-wise Comparison Matrix

Factor	Rainfall	Elevation	Slope	Geology	LULC	Drainage density	Geomorphology	Lineament Density	Soil type	Aspect
Rainfall	0.14	0.30	0.20	0.12	0.08	0.19	0.09	0.17	0.10	0.10
Elevation	0.05	0.10	0.33	0.12	0.08	0.19	0.09	0.17	0.10	0.10
Slope	0.05	0.02	0.07	0.12	0.25	0.19	0.04	0.17	0.10	0.10
Geology	0.14	0.10	0.07	0.12	0.08	0.06	0.26	0.17	0.10	0.10
LULC	0.14	0.10	0.02	0.12	0.08	0.06	0.09	0.06	0.10	0.10
Drainage density	0.05	0.03	0.02	0.12	0.08	0.06	0.09	0.06	0.10	0.10
Geomorphology	0.14	0.10	0.13	0.04	0.08	0.06	0.09	0.06	0.10	0.10
Lineament Density	0.05	0.03	0.02	0.04	0.08	0.06	0.09	0.06	0.10	0.10
Soil type	0.14	0.10	0.07	0.12	0.08	0.06	0.09	0.06	0.10	0.10
Aspect	0.14	0.10	0.07	0.12	0.08	0.06	0.09	0.06	0.10	0.10

Table 3 Random Index Value

Size of Matrix (n)	1	2	3	4	5	6	7	8	9	10
Random Index (RI)	0	0	0.58	0.9	1.12	1.24	1.32	1.41	1.45	1.49

Table 4 Aggregated weight for each parameter

Sl. No	Parameters	Weight
1	Rainfall	0.149
2	Elevation	0.133
3	Slope	0.111

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4	Geology	0.12
5	LULC	0.087
6	Drainage density	0.071
7	Geomorphology	0.09
8	Lineament Density	0.063
9	Soil type	0.092
10	Aspect	0.092

Table 5 Thematic layers with class influences and weighting

Parameters	Feature class		
l	240 – 1320	minimal	
	330 – 1400		
	410 – 1470	rate	
	480 – 1550		
	560 – 1630	mely Elevated	
	6-56	mely Elevated	
	57-150		
	160-320	rate	
	330-550		
	560-930	minimal	
	0-4	e slope	
	4.1-7.7	rately sloping	
	7.8-15	rate steep sloping	
	16-25	sloping	
	26-60	steeply sloping	
ament Density	<1	minimal	
	32-64		
	64-96	rate	
	96-128		
	>160	mely Elevated	
	Waterbodies & River	mely Elevated	
	Agricultural Land		
	Build up Rural & Urban	rate	
	Forest		
	Coastal line	minimal	
morphology	Pediment Pedi plain	mely Elevated	
	Water bodies and river		
	Dissected Hills and valley	rate	
	coastal		
	Hills and Valley	minimal	
ogy	Charnockite gneissic	mely Elevated	
	Khondalite		
	Migmattie	rate	
	Late Cretaceous		
	Warkali	minimal	
ct	North	mely Elevated	
	Northwest		
	West	rate	

	South		
	Southwest	minimal	
inage Density	<1	minimal	
	58-110		
	120-170	rate	
	180-230		
	>290	mely Elevated	
	Clay	mely Elevated	
	Sandy Clay loam		
	Sandy Loam	rate	
	Clayey Sand		
	Sand	minimal	

Table 6 Land use /Land cover

Regions	Area Km²
River	5.728428
Coastal region	5.28662
Forest	103.087674
Agriculture land	124.621588
Waterbodies	32.176264
Urban	22.741302
Rural	57.922124
Total	**351.564**

Table 7 Groundwater Potential Zone Classification

Sl. No	Classification	Total Sub -SurfaceArea (Km²)	Percentage (%)
1	Very good potential zone	90.295	25.68
2	Good potential zone	85.004	24.18
3	Moderate potential zone	70.713	20.11
4	Low potential zone	63.422	18.05
5	Poor potential zone	42.130	11.98

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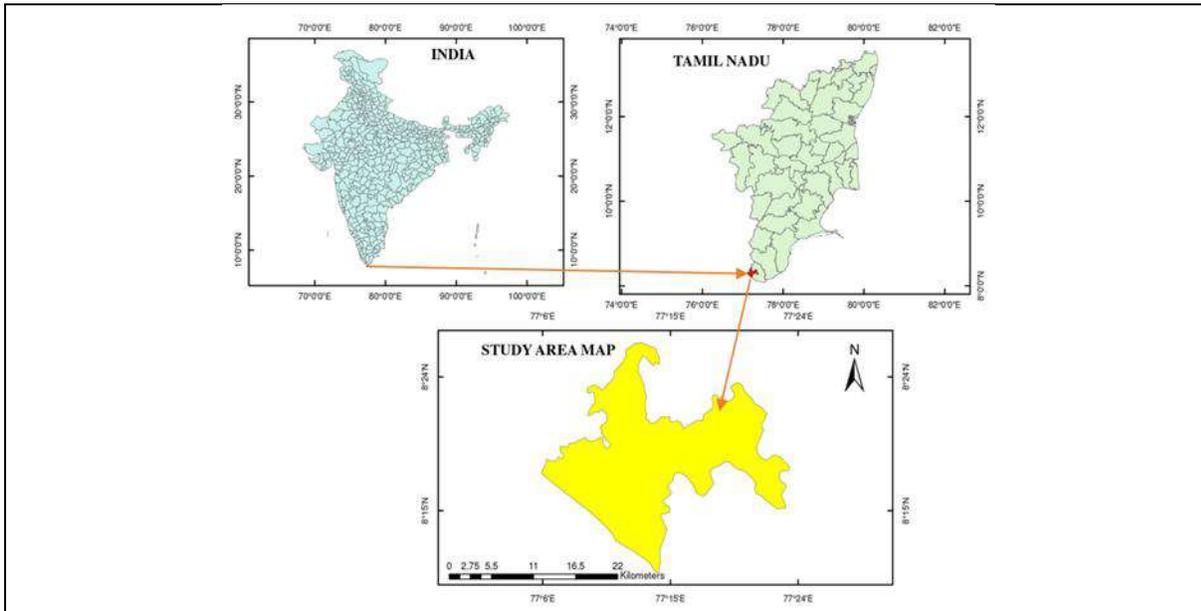
Figure 1 Location of the study area
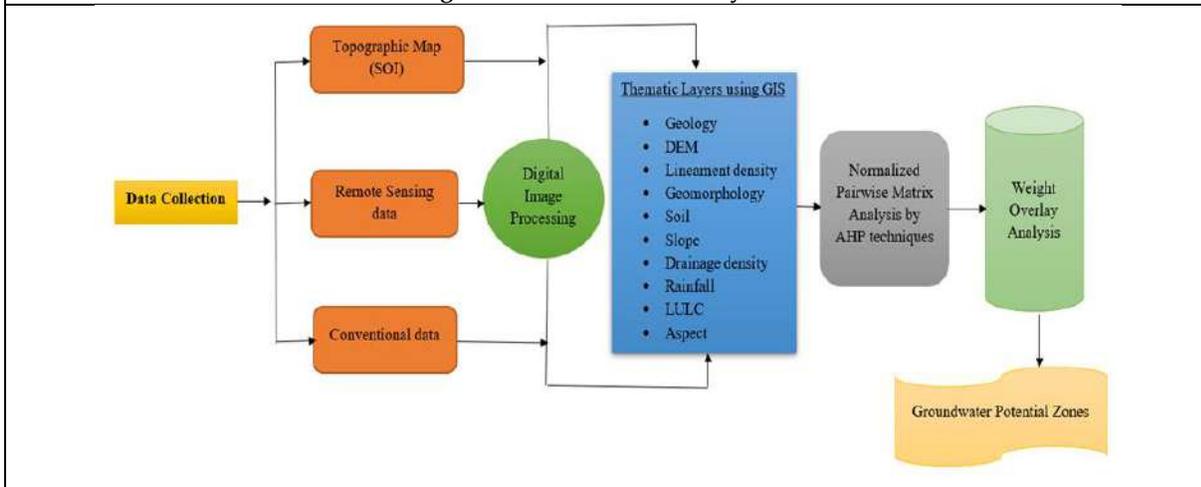
Figure 2 Flow chart of Methodology

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Figure 3 Digital Elevation Model of Kuzhithuraiyar Sub-basin

Figure 4 Lineament Density Map of Kuzhithuraiyar Sub-basin

Figure 5 Geomorphology Map of Kuzhithuraiyar Sub-basin

Figure 6 Soil Map of Kuzhithuraiyar Sub-basin.

Figure 7 Slope Map of Kuzhithuraiyar Sub-basin

Figure 8 Drainage Density Map of Kuzhithuraiyar Sub-basin
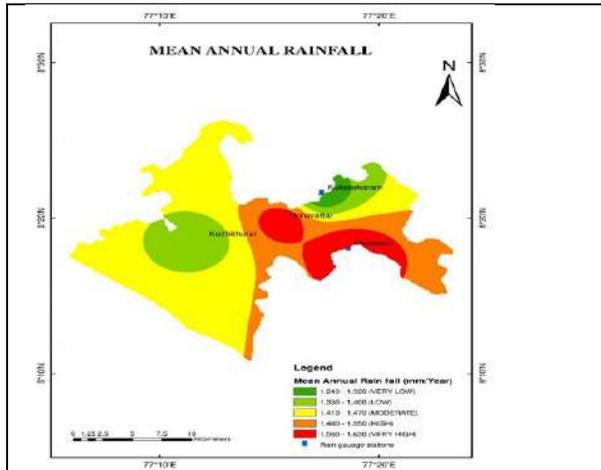
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Figure 9 Rainfall Map of Kuzhithuraiyar Sub-basin
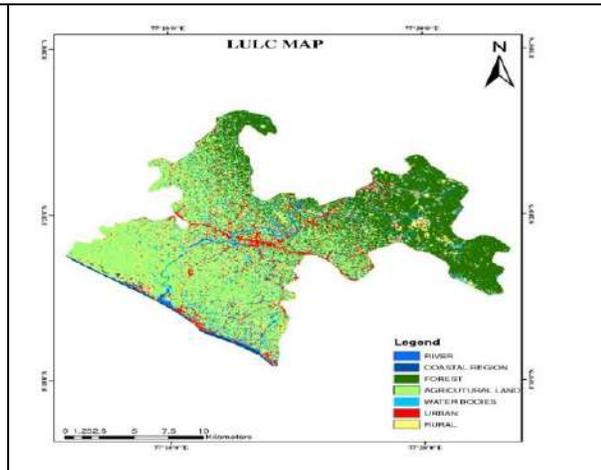
Figure 10 LULC Map of Kuzhithuraiyar Sub-basin
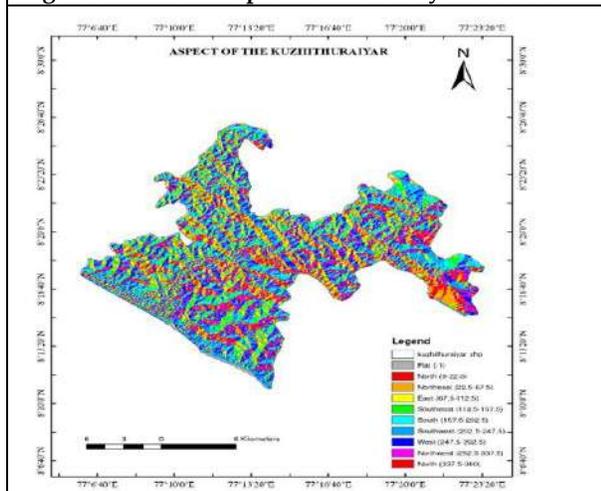
Figure 11 Aspects Map of Kuzhithuraiyar Sub-basin
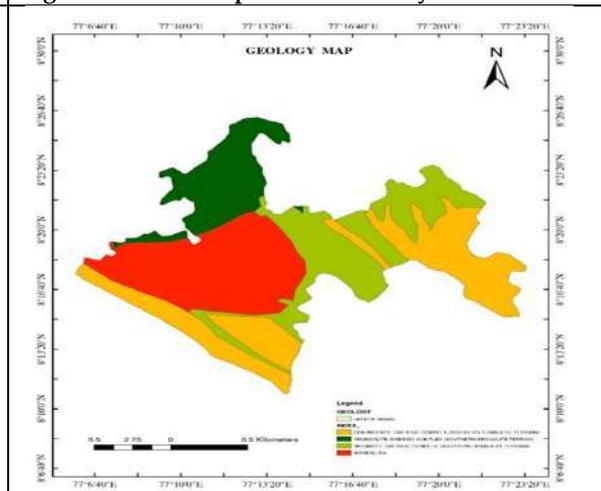
Figure 12 Geology Map of the Kuzhithuraiyar Sub-basin.

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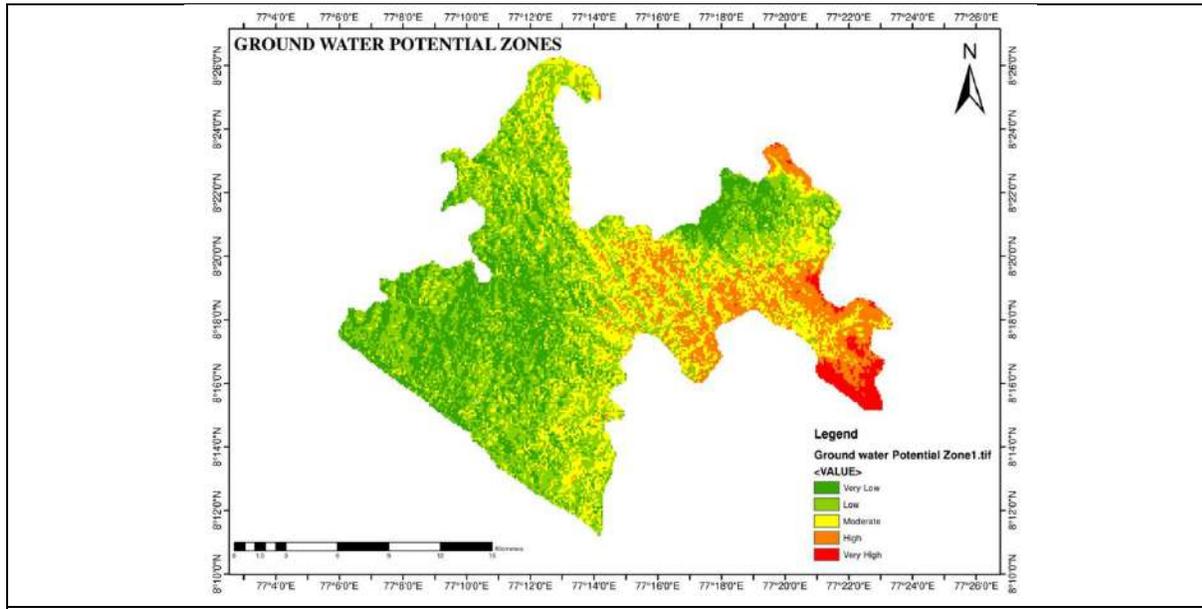
Figure 13 Groundwater Potential Map of Kuzhithuraiyar Sub-basin

REVIEW ARTICLE

Role of Edible Insects as Food Source: A Review

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ABSTRACT

The consumption of insects, known as entomophagy, is a topic that has gained significant attention due to its potential health, environmental, and economic benefits. Eating insects has been practiced by various cultures for centuries, but it has gained renewed interest on a global scale due to the recognition of its potential benefits. Edible insects are shown to have comparable or even superior nutritional profiles compared to traditional protein sources like birds and mammals. They are often rich in protein, healthy fats, vitamins, and minerals, making them a valuable dietary option. Insect farming is often touted as a more sustainable form of protein production compared to conventional livestock farming. Insects require less land, water, and feed to produce the same amount of protein. This can potentially reduce the environmental impact of food production and alleviate resource scarcity issues. The review discusses the multifaceted aspects of entomophagy, ranging from nutritional benefits and environmental advantages to challenges related to consumer perceptions and food safety. The potential of edible insects to

contribute to food security and sustainability is being explored, but overcoming obstacles such as cultural resistance and regulatory hurdles remains a crucial part of realizing these benefits.

Keywords: Edible insects, entomophagy, nutritional benefits, economic benefits

INTRODUCTION

Regular insect consumption has been estimated to form part of traditional diets of over two billion people worldwide (Van Huis et al., 2013). While some edible insect species, such as grasshoppers and locusts, require the removal of legs and wings prior to consumption, many edible insect species can be consumed whole, but may also be processed into powder or paste. Lepidopterans, Orthopterans, Isopterans and Hymenopterans are all regarded as common food sources in many areas. Culturally and religiously, entomophagy is particularly popular in tropical and subtropical regions due to the warm and moist climate (Jongema et al., 2017). Tropical insects are generally large in size with stable life history, which can facilitate harvesting (Gaston & Chown, 1999). The immature forms of insects (pupae and larvae) are preferred for their abundant amino acids and fatty acids, which not only ensure the nutritional value, but also provide a unique and splendid flavour. Insects were unable to offer the same benefits and were uncertain staples due to their seasonality. This may have contributed to a decrease in interest in insects as a food source (DeFoliartet al., 1999) [4]. Insect eating has recently captured public attention worldwide. Edible insects have the potential to become a major global future food (Caparros Megido et al., 2018)[5]. due to the presence of high-quality protein, vitamins and minerals as well as economic and environmental benefits. Edible insects could become part of a strategy for achieving food security worldwide (Van Huis et al., 2017) . Great attention has been paid to the utilization and production of edible insects. The production of animal protein is under huge pressure as the world population is rapidly increasing (Gerland et al. 2014).Consequently, people are facing the enduring protein undernourishment and seeking alternative protein resources Increasing number of people are joining the industry. However, the industrial chain of edible insects, from fundamental research to marketing, still needs to be developed.

Nutritional value of insects for human consumption
The nutritional content of edible insects can vary significantly based on factors such as species, metamorphic stage, habitat, and diet. This variability is especially pronounced in holo metabolous species like ants, bees, and beetles. While insects' amino acid compositions are similar to those of traditional animal foods, they can provide essential amino acids at ideal levels. This contributes to their potential as a high-quality protein source for both humans and animals. (Raubenheimer & Rothman, 2013).Edible insects are generally rich in protein. The proportion of crude protein in insects ranges from 40% to 75% on a dry weight basis. Comparatively, this protein content is higher than that found in conventional meat sources. Insects' proteins are highly digestible, with values ranging from 76% to 96%. This means that the nutrients present in insects are efficiently absorbed by the human body, further enhancing their nutritional value(Nowak et al., 2016). In addition to their potential benefits for human nutrition, edible insects can also be valuable as a source of nutrients for poultry. They offer a sustainable alternative to conventional feed sources. (Lange et al.,2021). Edible insect species are good source of essential amino acids that humans need for proper growth and functioning (Belluco et al., 2013).

The consumption of insects, also known as entomophagy, has been gaining attention as a potential solution to various global challenges, including improving the nutritional quality of human diets. Insects are a highly sustainable and efficient source of protein, and they offer a range of nutritional benefits (Bukkens et al.,1997). The nutritional composition of insects as a potential food source, particularly in terms of amino acids. The balanced diet requirements when insects constitute a significant portion of a meal and mentions that insects generally meet the World Health Organization's (WHO) recommendations for essential amino acids. most insect species can provide sufficient essential amino acids by consuming a reasonable combination of foods. All insect groups seem to be eligible sources of amino acids like isoleucine, leucine, lysine, phenylalanine, threonine, valine, arginine, histidine,

and tyrosine. The Blattodea group of insects tends to be particularly rich in lysine, valine, methionine, arginine, and tyrosine compared to other insects. Coleoptera, or beetles, are highlighted for having higher amounts of leucine compared to other protein sources, including livestock. Hemiptera, a group that includes true bugs, typically contains higher levels of phenylalanine compared to other protein sources. Nymphs are particularly rich in arginine, which is beneficial for heart and blood vessel conditions and can boost the immune system. In fact, the passage indicates that nymphs of certain cockroach species (Blatta lateralis) have more than twice the amount of arginine compared to beef and pork. Insects are generally abundant with fats. Lepidopteran and Heteropteran larvae (caterpillars and nymphs, respectively) often have higher fat contents compared to other stages of insects.

 Larvae are good source of fatty acids or oil related with other stages of insects. As for adult insects, they generally have lower fat content, often less than 20% of their body weight. The main storage form of fat in insects is triacylglycerol, also known as triglycerides (Arrese & Soulages, 2010). The content of saturated fats (SFAs) is often higher than that of monounsaturated fats (MUFAs) in the diets of many adults, MUFAs are generally considered healthier for human diets due to their positive effects on heart health (Sales-Campos et al. 2013). Insects are indeed rich sources of various vitamins and micronutrients, and they can provide a valuable nutritional resource for human consumption. Insects can provide a range of vitamins essential for human health, including vitamin A,B,C,D,E and K, which are needed for normal development and body function. For example, caterpillars can be a good source of certain B vitamins, including B1 (thiamine), B2 (riboflavin), and B6 (pyridoxine), as well as other essential nutrients. (Rumpold & Schluter, 2013). While crickets and termites are containing high concentrations of Zinc and Iron. Copper, magnesium, manganese and zinc levels in grasshoppers and mealworms are higher than those in beef (Christensen et al., 2006) certain insects like grasshoppers and mealworms can contain higher levels of certain minerals like copper, magnesium, manganese, and zinc compared to beef(Latunde-Dada).

Current entomophagy

The most prevalent commercial edible insect species are *Bombyx mori* (farmed silkworm),*A. mellifera* (honeybee), *Tenebrio molitor* (yellow meal worm), Imbrasia*belina* (mopane caterpillar), and Rhynchoporus *phoenicis* (African palm weevil) at the moment. These insects are being explored and utilized as alternative sources of protein and nutrition in various parts of the world. the industrial production of Tenebrio Molitor (mealworms) and orthopterans (such as crickets) as a potential food source. Mealworms are often used in various applications, including animal feed and even human consumption due to their high growth rate and ability to thrive on low-nutritional waste. Crickets are also considered as a potential food source, particularly their adult stages, and are easy to harvest when they swarm. However, there are concerns about the safety of consuming insects like crickets that might have been exposed to pesticides. Pesticide residues can accumulate in the insects if they are exposed to pesticides during their life cycle. These residues can potentially pose risks to human health if the insects are consumed, especially in large quantities (Ramos-Elorduy & Moreno, 2002). Honeybees are indeed important pollinators and honey is a well-known food product derived from their activities, the consumption of bee brood extracts as luxury nourishments is a cultural practice that varies by region and is not a common or mainstream food source (Chen et al. 1998). Entomic sugars are sweet substances produced by insects, and honey is one of the most well-known examples.

Lerp contains various components including monosaccharides and water-insoluble carbohydrates, as well as minerals like potassium and phosphorus, making it a potentially valuable nutritional source. However, lerp's production process currently relies on nature, as it can only be collected from host plants that are infected with the corresponding psyllids. This suggests that there might be some challenges associated with the scalability and reliability of lerp production, as it is dependent on the presence of specific insects and their interaction with plants (Van Huis et al. 2013).Edible insects are increasingly being recognized as a valuable source of nutrition for both human consumption and animal feed, including livestock and aquaculture (Józefiak et al. 2016). Feeding insects to livestock and aquaculture is seen as a way to enhance the nutritional value of the final products, such as meat or fish. Insects are rich in protein, essential amino acids, and other nutrients, making them a viable alternative to traditional feed sources like grains and soy. Feeding insects to livestock and aquaculture is seen as a way to enhance the nutritional value of the final products, such as meat or fish. Insects are rich in protein, essential amino acids, and

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other nutrients, making them a viable alternative to traditional feed sources like grains and soy. Additionally, certain types of insects, such as the pupae of Chironomidae and Muscidae, are utilized as fishing bait and feed for aquatic animals. This further highlights the versatility of insects in various applications within the animal industry. Insects can be raised on organic waste and agricultural byproducts, reducing the environmental impact and creating a more sustainable protein source ((Liu et al. 2010).

Food security

The FAO has indeed projected that the global population will reach over 9 billion by the year 2050. This population growth will undoubtedly put significant pressure on the agricultural sector to increase food production to meet the rising demand. (Belluco et al., 2013).The increase in human population indeed places greater demands on our global food supply, while various factors such as urbanization, deforestation, and climate change contribute to the decrease in available land for agriculture (Premalatha et al., 2011). As agricultural productivity decreases due to climate change, the availability of food can be compromised. This can lead to food shortages, higher food prices, and increased competition for limited resources. Vulnerable populations, particularly in low-income countries, are more likely to face difficulties in accessing sufficient and nutritious food. Enhanced socioeconomic situations and food access will therefore be desirable worldwide. Edible insects have gained attention as a potential solution to addressing malnutrition and food insecurity, particularly in regions where traditional food sources are limited or scarce. Edible insects are rich in essential nutrients such as protein, vitamins, minerals, and healthy fats. They can provide a well-rounded nutritional profile, contributing to human health and well-being. For example, insects like crickets and mealworms are high in protein and contain valuable amino acids. Establishing insect production sectors can create new economic opportunities for communities, from farming and processing to distribution and marketing of insect-based products (Kalemu et al., 2015).Insects are indeed rich in nutrients and can provide a suitable environment for microorganisms to thrive. This is due to factors like their high protein content and moisture levels.

As a result, the risk of parasites and microbial contamination in insect products is a concern. Microbial hazards, including various types of bacteria like Entero bacteriaceae and sporulating bacteria, can be present in insects. These microorganisms can pose a risk to human health if ingested. Simply boiling or cooking insects might not be enough to completely eliminate these microbial risks. (Klunder et al., 2012). Preventive measures are essential throughout the stages of insect production and storage to ensure the safety of insect-based products for consumption. Climate change can have a significant impact on insect populations, just as it does on other species. Sustainable harvesting practices are crucial to ensure that insect populations aren't overexploited, which can lead to cascading effects in ecosystems. The example of the African Goliath beetle you mentioned is interesting. It showcases how shifting from harvesting insects directly from nature to rearing them can contribute to the conservation of both the insects and their habitats. By cultivating these insects in controlled environments, their populations can be better managed, and the potential threats they pose to their natural hosts can be mitigated (Neuenschwander et al., 2011).

Environmentally and economically benefits

Insects are often used as food due to their low cost. Wild species that are abundant can be harvested at minimal expense. Farming species tend to feed on inexpensive feed sources, which contributes to cost-effective production. Insects, such as Tenebrio molitor (mealworm), exhibit a high efficiency of converting ingested food into usable energy. The efficiency of conversion of ingested food (ECI) for T. Molitor is notably higher (53-73%) compared to other animals (Morales-Ramos & Rojas, 2015). This high conversion efficiency makes insects an efficient source of nutrition. Insects have lower carbon and water footprint, as well as lower ammonia emissions, compared to traditional livestock. This can be beneficial for both the economy and the environment. Insects generally have shorter life cycles compared to other traditional protein sources (Wilkinson, 2011). This means they can be bred and harvested more quickly, requiring less breeding space. This efficiency in production can contribute to a more sustainable food supply. Despite the low cost of production, edible insects are often sold at high prices in the market. This presents significant income opportunities for individuals and communities globally. This economic potential can contribute to livelihoods and development (Payne, 2014). Insect consumption could lead to a decreased demand for traditional chemical pesticides. Edible insects that are considered pests of economic plants could be harvested

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and used as a food source, thereby managing their populations. This approach has the potential to mitigate the damage caused by these pests without resorting to chemical treatments. By artificially harvesting edible insects, there's the potential for generating additional profits (Kouřimská & Adámková., 2016). One significant advantage of reduced pesticide usage is the potential for slowing down the development of pesticide resistance in insects. The principles of IPM, which is a holistic approach to pest management that combines various methods, including biological control, cultural practices, and the limited use of pesticides when necessary. The goal of IPM is to manage pests in an environmentally sensitive and economically viable manner (DeFoliart, 1997).

The primary idea behind using edible insects as a food source is to reduce the environmental impact of conventional livestock farming, which often requires significant resources such as land, water, and feed. However, in order for edible insects to have a meaningful impact, they need to be produced on a large enough scale to partially replace traditional protein sources like meat. This involves establishing insect farming operations that can meet the demand. The methods used for insect farming and processing could potentially have hidden or unforeseen environmental costs. These might include energy consumption for climate control in insect farming facilities, the sourcing of feed for the insects, the energy and resources needed for processing, and the transportation of insect products. edible insects could be a panacea for various challenges (climate change, resource scarcity, health issues) might be oversimplified. While edible insects offer potential benefits, they might not be a silver bullet solution to all these complex problems. It's important to approach their use with a balanced understanding of their advantages and limitations. the need for further research to comprehensively assess the environmental impacts of large-scale insect farming.

This research should consider the entire lifecycle of insect production, from rearing to processing to transportation, and compare it to existing livestock and farming practices. The potential of edible insects as a sustainable food source to meet the nutritional needs of a growing global population. The potential socio-economic benefits of insect gathering and farming in improving food security, particularly in low-income settings, need further exploration and clarification. The environmental impacts and sustainability of rearing, harvesting, and producing insects are highlighted as areas of concern. Comparisons with traditional farming and livestock raising are suggested to understand the potential environmental benefits of insect-based food sources. While insects are seen to involve fewer animal welfare issues compared to traditional livestock, there's a need to better understand the extent to which insects might experience discomfort or pain. the International Centre of Insect Physiology and Ecology (ICIPE) in Nairobi, Kenya, as an example of multidisciplinary research in the field of edible insects. ICIPE's mission is to ensure food security and enhance the health status of people in tropical regions through insect management strategies. Comprehensive legal frameworks at national and international levels are deemed necessary for producing and trading insect products. These frameworks would help secure investments and establish appropriate business structures (Erens et al., 2012).

CONCLUSION

The use of edible insects as a sustainable food source has indeed gained significant attention worldwide. Many insect species are rich in protein, healthy fats, vitamins, and minerals. They can provide a highly nutritious food source that can help address malnutrition and protein deficiency, especially in regions where access to traditional protein sources is limited. Edible insects can be utilized in various ways beyond direct consumption. The development of modern insect-based products demonstrates the versatility of these resources. Moreover, the growing popularity of consuming insects goes beyond just their nutritional benefits, extending into the realm of novelty and enjoyment. The discrepancy between the potential benefits of edible insects and their current market status is an important observation. Effective strategies for promoting and producing insect-based products are essential to bridge this gap. Semi-cultivation is proposed as an approach to boost insect production efficiently, which could help meet the rising demand for insect-derived products. Standardization is emphasized both in farming and processing to maintain the quality and safety of insect products. Consistent quality control measures are necessary to build consumer trust and ensure that insect-based foods are safe for consumption. Promoting communication and collaboration between insect

farms and processing industries is a sound recommendation. Efficient cooperation can lead to higher profits and a more streamlined supply chain. Lastly, the concept of agricultural-industrial integration is a valuable insight. As new insect products are developed, cultivation techniques improve, and production processes are optimized, the entire industry can benefit from a holistic approach that maximizes the potential of edible insects to address global nutritional challenges.

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RESEARCH ARTICLE

Oxidative Stress Causes Consequences and the Role of Phyto medicine in Modern Prospects

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ABSTRACT

In a living system lots of biochemical reactions are running which simultaneously may generate various free radicals and reactive oxygen species. Their elimination must be required for the survival of the organism. For the accomplishment of this task the body has its antioxidant mechanism but it may collapse when free radicals are generated in huge amounts. The higher concentration of ROS and free radicals may lead to disturbance in physiology ultimately leading to a pathological condition. The present review describes the cause, and impact of oxidative stress in the body. In the modern age due to the limitation of synthetic drugs, researchers are centric on to use of medicinal plants to avoid oxidative stress in normal conditions as well as in pathological conditions. Plants possess various phyto constituents which may have a therapeutic effect on the body. These phyto constituents are also considered phyto medicine because of possess medicinal activity. There view also focuses on phyto medicine's use to get rid of oxidative stress

Keywords: Oxidative stress, free radicals, ROS, cancer, phyto medicine, medicinal plant

INTRODUCTION

Reactive oxygen species (ROS) and free radicals contribute to oxidative stress. Molecules are stable with paired electrons, but a single electron in an orbital makes them highly reactive. Those with unpaired electrons seek to fulfill their deficiency by capturing electrons from external substances. The oxygen triplet, with two unpaired electrons, is a

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significant source of free radicals, and although reactions are slow, they can still generate ROS when interacting with other molecules [1].Electron deficiencies in molecules negatively affect living systems, causing abnormalities in function and physiology. Reactive oxygen species (ROS), with unpaired electrons, have a crucial role in limited quantities for cell signaling but become harmful in excess. Various sources and causes in the human body lead to the production of free radicals, as outlined in the next section.

Production of free radicals species

Reactive Oxygen Species (ROS), notably the highly reactive oxygen triplet, can damage cells and DNA through oxidation. Mitochondria are a major source of ROS in both normal and pathological conditions. Enzymatic processes, like those in the respiratory chain and cytochrome P450 system, contribute to ROS production. External factors like UV radiation and pollutants also trigger ROS. The body's internal defenses neutralize ROS, but external antioxidants may be needed if the defense system fails [2, 3, 4]. Living systems release reactive oxygen species (ROS) through enzymatic processes like phagocytosis, cytochrome P450, prostaglandin production, and the respiratory chain system. Superoxide radicals, formed by these processes, can further produce diverse free radicals, with enzymes like peroxidases, nicotinamide adenine dinucleotide phosphate oxidase, and xanthine oxidase contributing to superoxide radical production, and non-enzymatic reactions generating free radicals during mitochondrial respiration[5]. Internal processes such as immune cell activation, oedema, ischemia, infection, cancer, physical exertion, mental stress, and aging generate free radicals[6, 7].External factors like environmental pollutants, heavy metals (e.g., Arsenic, Iron, Cadmium, Lead Mercury), certain medications (gentamycin, bleomycin, tacrolimus, cyclosporine), chemical solvents, smoking, alcohol, and radiation exposure can generate exogenous free radicals. Metabolism or breakdown of these substances within the body produces free radicals as byproducts.

Free radicals' physiological activities

Free radicals in biological systems play vital roles in defending against pathogens by contributing to the formation of cellular structures, with phagocytes producing and storing them, releasing when needed to eliminate invading microbes. [8, 9].Free radicals are crucial in the immune system, evident in individuals with granulomatous disease susceptible to chronic infections due to a defective NADPH oxidase system. Beyond immune function, they serve as key regulators in cellular signaling pathways, influencing intercellular signaling in various tissues such as fibroblasts, thyroid tissue endothelium, vascular smooth muscle cells, and cardiovascular myocytes, and are integral to nitric oxide signaling pathways, contributing to non-specific host defense and cellular responses. [10, 11, 12].

Free Radicals' Negative Effects on Human Health

Biological oxidizers consist of many ROS, but oxygen stands out as the most abundant and effective oxidant. It has an increased oxidation capacity when a proton is added to it Here, we will discuss the functions and structures of some essential oxidizers. Table 1 demonstrates the Source and physiological response of various types of ROS The metabolic processes of cells can be negatively affected by the products of free radicals, which may ultimately lead to cellular harm.

1.   Lipid peroxidation caused by free radicals can decrease the flexibility of polyunsaturated membrane walls, ultimately resulting in cell lysis[13].
2.   Free radicals can negatively impact cellular metabolism and cause damage to cells by decreasing the fluidity of polyunsaturated membranes, resulting in lipid peroxidation and eventual cell lysis[14].
3.   Several important proteins may become inactivated or denatured due to the actions of free radicals[15].
4.   Free radicals can cause mutations and carcinogenic effects by modifying the bases that make up nucleic acids[14].

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Free radical-related physiological and physio pathological phenomena (FR)

Excessive free radical production, stemming from physical or biochemical activity, can lead to various pathological conditions in the human body, including cell aging, diabetes, coronary artery disease, inflammatory illnesses, cancer, mutations, cell transformation, and myocardial infarction. Beyond a certain threshold, the accumulation of free radicals and oxidants induces oxidative stress, negatively impacting cellular structures. Oxidative stress occurs when the body's enzymatic defense system fails to eliminate radicals like hydroxyl radicals and peroxynitrite, causing lipid peroxidation and damaging cell membranes and lipid proteins. This process leads to the rise of cytotoxic and mutagenic compounds like malondialdehyde and conjugated dienes within the cell, initiating a radical chain reaction that swiftly affects multiple lipid molecules[7].Oxidative stress can modify proteins, altering their structure and diminishing enzymatic activity. Additionally, it damages DNA, causing lesions like 8-oxo-2'-deoxyguanosine (8-OHdG), a highly harmful lesion capable of inducing mutagenesis and mutation[16]. Additionally, it can cause a loss of epigenetic information, which is likely due to a deficiency in the methylation of CpG islands in gene promoters [17]. Researchers have proposed 8-OHdG levels in tissues as a biomarker of oxidative stress, highlighting its significance. Cells possess various defence mechanisms against DNA damage, including antioxidants and base excision repair (BER)[18,9,5,11]. DNA, highly vulnerable to oxidative stress, can result in the hazardous DNA lesion 8-oxo-2-deoxyguanosine (8-OHdG), causing detrimental mutations and loss of epigenetic information through CpG methylation in gene promoters. Researchers use 8-OHdG levels as a tissue biomarker for oxidative stress[19]. The cell employs repair mechanisms, like base excision repair and antioxidants, to mitigate oxidative stress. Unregulated oxidative stress can lead to chronic diseases, accelerated aging, and acute pathologies such as stroke and trauma.

Oxidative Stress and Oncology

Cancer, influenced by internal and external factors like genetics and the environment, often arises from DNA damage. Oncogene activation and chromosomal abnormalities, key drivers of cancer, result from a redox imbalance caused by DNA hydrolysis by-products. This hydrolysis induces oxidative stress and chemical carcinogenicity, disrupting normal cell growth and causing mutations that alter the transcriptosome profile. Oxidative stress leads to various DNA modifications, including base and sugar lesions, DNA protein crosslinks, strand breaks, and base-free sites, promoting tumor growth. Sources of DNA damage contributing to tumorigenesis include tobacco smoking, environmental pollutants, and chronic inflammation [20,21]. The development of cancer can also be attributed to oxidative stress induced by unhealthy lifestyle choices and behaviours.

Cardiovascular diseases (CVDs)

Factors like hypercholesterolemia, hypertension, smoking, and stress-related illnesses contribute to severe complications in cardiovascular diseases. Recent research emphasizes oxidative stress as a primary or secondary factor in their pathogenesis, promoting atherosclerosis.

Atheromatous plaque induces endothelial inflammation, triggering ROS production by macrophages that oxidize LDL, leading to foam cell formation and lipid deposition, contributing to atherosclerotic plaque development. Oxidative stress is identified as a major underlying cause of diseases, including congestive heart failure, cardiomyopathy, atherosclerosis, ischemia, hypertension, and myocardial infarction[22, 23, 24]

Oxidative stress and neurological disorders

Neurological conditions like Parkinson's, Alzheimer's, ALS, depression, and memory loss are associated with redox imbalance. In Alzheimer's research and clinical trials, oxidative damage has been linked to neuronal destruction, increasing dementia risk. The generation of beta-amyloid, a harmful peptide prevalent in Alzheimer's patients and a key factor in neuro degeneration, is thought to be driven by free radicals. [25].

Oxidative Stress and Pulmonary Disease

Several researchers have noted the association between oxidative stress and conditions such as asthma and other chronic obstructive pulmonary diseases[26,27]. Oxidants trigger the activation of multiple kinases and transcription factors, including NF-kappa B and AP-1, thereby accelerating the inflammatory process. [28, 29].

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Oxidative Stress and Osteoarthritis

Arthritis is a chronic inflammatory condition affecting both the tissues surrounding the joint and the joint itself. The presence of macrophages and activated T cells within these tissues provides insight into the nature of this disorder[30, 31].Free radicals at inflammation sites contribute to disease progression by increasing isoprostane and prostaglandin levels in synovial fluid, acting as inflammatory mediators that intensify the inflammatory response[30].

Oxidative Stress and Renal Disease

Oxidative stress can trigger a range of kidney and nephron-related disorders, such as glomerulonephritis, kidney failure, proteinuria, and interstitial nephritis[31]. Oxidative stress negatively impacts kidneys, stimulating pro-inflammatory cytokines' production by free radicals, initiating inflammation, and leading to renal failure through a process involving TNF-alpha, IL-1b, NF-κB, kb, TGFβ, and medication-induced elevation of free radical levels and lipid peroxidation. [32, 33]. Nephron-related diseases and cancers can arise from exposure to heavy and transition metals inducing significant oxidative stress [3, 4].

Oxidative Stress and Biological Age

The impact of oxidative damage on sexual maturation and the onset of puberty has been acknowledged by multiple scholars. [34, 35].Prepubertal exposure to heavy metals like cadmium and pregnancy can lead to the generation of free radicals in children, causing oxidative stress. The imbalance between pro-oxidants and antioxidants characterizes oxidative stress, marked by an excessive increase in reactive oxygen species (ROS) due to inadequate antioxidant defense or a breakdown in the cells' buffering system. These changes in biomolecules define the disease condition [36]. Molecular damage and/or disruption of redox signalling and regulation were used to redefine oxidative stress, which was previously thought to be "a disturbance in the prooxidant - antioxidant balance in favour of the former" [37, 38].

Oxidative stress and free radicals pose a significant and widespread risk to human health, evident in their involvement in various clinical disorders affecting multiple tissues and systems.

Antioxidants' function

Biological systems under oxygenated conditions deploy both pharmacological and physiochemical defense mechanisms. Physiologically, oxygen levels in tissues and cells are maintained, while the biochemical defense system employs specific enzymes to counteract free radicals and oxidative stress. Non-enzymatic processes may also be involved, utilizing molecules that function as antioxidants.

Endogenous system of Antioxidant

Living systems have antioxidant enzymes like catalase, glutathione peroxidase, superoxide dismutase (SOD), and DT-diaphorase. Notably, SOD, an endogenous enzyme, is crucial for neutralizing oxygen radicals by interacting with hydrogen, playing a dominant role in eliminating free radicals. Various types of SOD differ based on the metal cofactor they use[39, 40]. This enzymatic reaction leads to the formation of hydrogen peroxide, which is subsequently broken down into water and oxygen by catalase (CAT). In this manner, the detoxification and elimination of free radicals occur [41].Catalase (CAT) efficiently breaks down H_2O_2 into H_2O and O_2 within seconds. Glutathione peroxidase (GPx), a crucial intracellular enzyme, degrades lipid peroxidation products into alcohols and hydroxyl radicals, mainly in mitochondria and occasionally in the cytosol [42]. Selenium plays a vital role in the GPx mechanism. The human body harbours between eight and ten different types of GPx enzymes, ranging from GPx1 to GPx8 [43]. The selenoperoxidase GPx1 is the most prevalent among them and is found in all cells. To prevent oxidative stress on cells, the GPx1 enzyme slows the process of lipid peroxidation [44].Insufficient levels of GPX1 render cells more susceptible to oxygen-induced damage and the degradation of functional proteins. This can result in the destruction of proteins within the plasma membrane, leading to detrimental effects on the cell. According to Torayman[45], GPX1 is a crucial enzyme for both physical growth and the prevention of various disorders, including

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cancer and cardiovascular disease. The reduction of the quinone-containing medication and the reduction of quinone from quinol are both catalysed by DT diaphorase[46]. All these enzymes are regulated and synthesized by special genes present in DNA.

Exogenous system of Antioxidant and its types

Exogenous antioxidants, acquired from food or nutrients, neutralize existing free radicals by donating electrons. This generates less reactive free radicals within the antioxidants themselves, efficiently eliminated in the body. Antioxidants like vitamin E, carotene, ferritin, reduced glutathione, manganese, ubiquinone, zinc, flavonoids, and melatonin are easily eliminated. We'll explore these exogenous antioxidants, their therapeutic activities, and protective functions in the following discussion.

Vitamin E

Vitamin E includes lipophilic substances such as α, β, gamma, and δ-tocopherol, as well as α, β, gamma, and δ-tocotrienol, found in plants, edible oils, and seeds. α-tocopherol is the primary constituent. As an antioxidant, vitamin E counters chain reactions initiated by peroxy radicals, with its antioxidative properties extensively studied by researchers[47, 48, 49, 50].Vitamin E, with lipophilic substances like α, β, gamma, and δ-tocopherol, and α, β, gamma, and δ-tocotrienol, found in plants, oils, and seeds, is primarily composed of α-tocopherol. It acts as an antioxidant, countering chain reactions initiated by peroxy radicals, with antioxidative properties extensively studied by researchers[51,52]. The early development of an atherosclerotic lesion involves the conversion of macrophages into foam cells through oxidized low-density lipoprotein (LDL) uptake by the CD36 receptor. Vitamin E inhibits CD36 expression, thereby impeding foam cell formation. RRR γ-Tocopheral displays efficient pro-Inflammatory activity during allergic Inflammation.

Phenolic Compounds

Phenolic compounds, varying in size and biological activity, are natural or semi-synthetic substances characterized by phenolic structural units. Dietary sources of polyphenols include fruits, vegetables, cereals, and beverages, found in berries, grapes, apples, pears, cherries, byproducts, red wine, tea, coffee, chocolate, cereals, dry legumes, flowers, stems, spices, and herbs. Regularly consumed in many nations, polyphenols are potent antioxidants, with approximately 8000 types of phenolic compounds obtained through dietary intake.One gram per day or more of these substances may be consumed[53]. Synthesized in plants for defense, phenolic compounds are now used in drug manufacturing for therapeutic effects. They act as hydrogen donors, chelating metal ions like copper (Cu) or iron (Fe), inhibiting low-density lipid oxidation, and reducing the risk of neurodegenerative diseases. Phenolic compounds also show potential in treating various cancers and coronary heart disease[54-57]. According to Sakakibara et al., 2003. phenolic compounds also possess vasorelaxant and anti-allergic properties [58]. In vitro studies have demonstrated that phenolic substances can prevent the oxidation of low-density lipids [59]. The antioxidant properties of phenolic compounds decrease with solvents forming hydrogen bonds. For instance, alcohol and peroxy radicals act as hydrogen bond acceptors, and ionization forms phenoxide anions reacting with peroxy radicals, facilitating electron transfer. Solvents determining antioxidant capacity effectively ionize phenolic compounds.

Carotenes

Carotene compounds, present in plants, animals, and micro-organisms, boast around 700 identified variations. [60]. Carotenes typically exhibit a symmetrical tetraterpene framework, featuring a flexible 40-carbon straight hydrocarbon structure susceptible to morphological changes. These alterations include hydro-generation, geometrical isomerization, and the addition of cyclic or side groups post-glycosylation. Through diverse complexations, the linear skeleton transforms into a tetraterpene structure with approximately 50 carbons. Some carotenes, with a carbon count of 30, result from the condensation of two farnesyl units [61]. Carotenes, consistently identified in various studies, serve as precursors to vitamins and play a crucial role in shielding the animal body

from photo-oxidation by effectively neutralizing singlet oxygen species[62, 63, 64].Carotenes play a pivotal role in mitigating oxidative stress, offering protection against severe health issues like cardiovascular diseases, cancer, neurological disorders, and sight conditions associated with Reactive Oxygen Species (ROS). Their diverse physiological functions in the biological system encompass immune system stimulation and modulation of intracellular signaling pathways, including gap junction communication [65],Carotenes also regulate cell cycle progression and apoptosis, impacting the activity of growth factors and cellular proliferation [66], Carotenes also influence various receptor and adhesion molecules[67]. Carotenoids, particularly noteworthy for their potential in preventing bladder cancer, have been extensively studied epidemiologically. The findings suggest that specific carotenoids and carotenoid-rich diets may lower the incidence of bladder cancer[68,69].Carotenoids, being lipophilic, eliminate ROS from hydrophobic cell membrane and lipoprotein regions, reducing the risk of membrane oxidation and morbidity rates [70]. Carotenoid-rich diets have demonstrated a decrease in morbidity and mortality rates associated with atherosclerosis, a condition arising from oxidative changes in low-density lipoprotein within artery walls leading to cardiac disorders. Numerous studies support carotenoids' protective impact in various cardiovascular diseases, including atherosclerosis [71, 72,73].

Repair System

This process repairs biological molecules damaged by free radicals, including lipids, proteins, and DNA under oxidative stress. Without a repair mechanism, damaged DNA can lead to mutations, resulting in negative or positive evolution. In negative conditions, the organism may face extinction. A robust repair system is crucial, with cells containing essential DNA repair enzymes like nuclease, polymerase, and glycosylase. Proteolytic enzymes, including proteinases, proteases, and peptidases, play a vital role in protein metabolism. Specific enzymes like GPX, glutathione reductase, and methionine sulfoxide repair biological molecules damaged by free radicals.

Attributes of Antioxidants

An effective antioxidant efficiently neutralizes free radicals, responsible for oxidative stress, by detecting them within the biological system [74]. According to Gordon's classification, antioxidants are categorized as primary and secondary antioxidants [75]. Primary antioxidants intercept and actively neutralize free radicals, preventing oxidative chain reactions. In contrast, secondary antioxidants deactivate harmful metals, hindering lipid hydroperoxide formation. They suppress unnecessary volatile generation and promote primary antioxidant production, eliminating singlet oxygen. Overall, antioxidants impede oxidation in biological molecules, cells, and tissues, even in minimal amounts.[76].

Antioxidant's mechanism of action

Antioxidant effectiveness in test tube experiments may not always translate to in vivo conditions. Free radicals, with rapid diffusion and a short lifespan, pose a challenge for efficient trapping and neutralization by antioxidants. In such circumstances, significant oxidative damage can occur. The efficacy of antioxidants is influenced by factors such as free radical concentration and chemical properties, the surrounding medium, and prevailing reaction conditions

Potent Antioxidant Plant

Recent research has shown that certain plants effectively alleviate oxidative stress in the body [77- 93]. Table no.2 lists the plants which show significant antioxidant potential. These plants, whether consumed as food or used for medicinal purposes, have shown promising results

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Table 1: Various Kinds of ROS, their source and functions.

Species	Source	Function
Dioxygen (O^{2-})	Non-enzymatic electron transport reactions, autoxidation reactions, and enzymatic reactions	It acts as an oxidizing agent for ascorbic acid and tocopherol and a reducing agent for iron clusters like cytochrome-C.
Hydroperoxy radical	O^{2-} Protonation	HO_2 starts the oxidation of fatty acids.
Hydroxide (HO)	Through the metal-catalyzed Fenton reaction, H_2O_2 produces Ho.	Both inorganic and organic compounds, such as proteins, Fats DNA and carbohydrates are affected by HO's reactions.
Nitric Oxide	Utilizing arginine as a substrate and NADPH as an electron source, nitric oxide synthase produces nitric oxide.	NO is a second messenger that activates proteins, carbohydrates, guanylate cyclase and lipids inside cells.
Nitrogen dioxide (NO_2)	hemolytic disintegration of $ONOOCO_2$ or protonation of ONOO	Ascorbate and alpha-tocopherol levels in plasma are decreased by this radical's impact on the antioxidant system.
Carbonate (CO_3)	Superoxide dismutase (SOD) Cu^{2+} OH intermediates combine with bicarbonate to produce CO_3.	Biomolecules including proteins and nucleic acids are oxidized by Carbonate.
Nitrosoperoxycar bonic acid ($ONOOCO_2^-$)	The interaction of ONOO with Carbon dioxideproduces the peroxynitrite Carbon dioxide adducts.	Through FR, this anion encourages the nitration of oxyhemoglobin's tyrosine fragments.

Table 2: The following are examples of antioxidant plants and their corresponding phytochemicals that contribute to their antioxidant properties.

Botanical Name	The method used to evaluate antioxidant property	Result and reason behind possible antioxidant compound present in the plant	References
Bacopa monnieri (L.) Pennell	DPPH	Bacoside and Bacopasaponin	[77]
Tussilago farfara L. (Leaves) *Taraxacum officinale* L. (Leaves), *Artemisia dracunculus* L. (Leaves)	*ABTS Radical Cation, DPPH Radical*	3,4-dicaffeoylquinic acid, isomer 1 of chicoric acid, and 5-O-caffeoylquinic acid	[78]
Syzygium aromatium J. Presl (Seed) *Cinnamomum verum* J.Presl (Seed)	DPPH Assay	No specific compound was mentioned although plants contain quinones, triterpenoids, anthocyanins, leucoanthocyans, terpenoids, saponins, flavonoids, sterols, coumarins, and tannins	[79]
Acorus calamus **Linn.**	ABTS assay, DPPH assay, FARP method	Phenolics compound	[80]
Goniothalamus velutinus (Leaves and Bark)	ABTS assay, DPPH assay, FARP method	Phenolic compound	[81]

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Barringtonia racemose (Leaves)	DPPH Assay	Phenolics contents	
Cymbopogon citratus, Lawsonia inermis, Hibiscus sabdariff	ABTS assay, DPPH assay, FARP method	Phenolics Compounds	[82]
Macarangasub peltata	DPPH and FARP method	Phenolics and Flavonoid contents	[83]
Withania frutescens L. (Root and Leaves)	Ferric reducing the ability of plasma (FRAP), total antioxidant capacity (CAT), 2,2-diphenyl-1-picrylhydrazyl (DPPH), and the ß-carotene discolouration test are examples of lowering power tests.	Phenolics Compound	[84]
Quercus infectoria	DPPH Method	Tannin Content	[85]
Elaeocarpus tectorius (Lour.)	2,2-diphenyl-1-picryl-hydrazylhydrate assay, as well as tests for the scavenging of hydroxyl (HO%), superoxide anion (O_2%), and nitric oxide (NO%) radicals.	Phenolic Content	[86]
Evolvulus alsinoides, Ficusbeng alensis, Chicorium intybus (Whole plant)	DPPH Method	Phenolic content	[87]
Punica granatum peel extracts	CCl4 Induced Wister albino mice vivo method	Carotene	[88]
Emblica officinale (Fruit pulp)	DPPH and ABTS method, phosphomolybdenum assay, LPO	gallic acid, mucic acid ellagic acid quercetin, rutin and β-glucogallin	[89]
Citrus lemon (Peel)	DPPH and CUPRAC	Following limonene (67.1%), -pinene (11.0%), and -terpinene (8.0%)	[90]
Cumunis sativus (Peel)	phosphomolybdenum assay	Polyphenolic compound	[91]
Coriandrum sativum (Root)	FRAP and DPPH	Phenolic content	[92]
Ocimum sanctum	Cadmium-induced damage in albino rat	Eugenol and ursolic acid	[93]

RESEARCH ARTICLE

A Single Case Study to Evaluate the Effects of Ayurvedic Therapeutic Bio Purification for the Management of Plaque Psoriasis

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ABSTRACT

Plaque psoriasis, a persistent autoimmune skin condition marked by elevated, reddened, and flaky patches on the skin's surface, shares resemblances with *Ek Kuṣṭha* in Ayurveda. classification based on its clinical appearance. This study primarily aimed to evaluate the efficacy of a personalized traditional Ayurvedic treatment protocol in managing plaque psoriasis in a 49-year-old male patient. The approach involved bio purification through therapeutic emesis and purgation, coupled with oral and topical Ayurvedic remedies. Assessment of treatment effectiveness was based on the Psoriasis Area and Severity Index [PASI] score, Subjective criteria, and photographic evidence before and after the intervention. Results indicated a remarkable 95% decrease in the PASI score, an 82% enhancement in Subjective criteria, and noticeable photographic improvements. These positive outcomes can be attributed by the anti-inflammatory and antioxidant properties of the ayurvedic medications, supported by the facilitating impact of the therapeutic bio-cleansing processes. Consequently, this innovative personalized Ayurvedic strategy can holds promise for the management of plaque psoriasis

Keywords: Therapeutic Emesis, PASI Score, Ayurved, *Ek Kuṣṭha*, Virechana

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INTRODUCTION

Psoriasis is a common, persistent Papulosquamous skin condition that affects people of all ages and causes significant burdens on individuals and society [1] and it has a wide range of cutaneous symptoms, with individual lesions ranging from minuscule to massive plaques, and even generalized erythroderma. Most common and well-organized form of psoriasis is plaque psoriasis. [2] It affects approximately 0 % to 11.8 % in different population. [3] Precise Etiology is still uncertain however; it is speculated to be an autoimmune illness mediated by T lymphocytes. The pathogenesis includes activated T lymphocytes infiltrating to the skin and stimulating keratinocyte growth. this dysregulation results in the production of thick plaques along with hyperplasia and parakeratosis. [4] common clinical features include dry, itchy and raised skin patches covered with scales. Psoriasis Area Severity Index [PASI] is common tool to assesses the severity of the condition and treatment strategies includes Emollients, moisturizers and topical therapy like coal tar, dithranol, vitamin D analogues, keratolysis, corticosteroids and targeted phototherapy etc are in practice. [5] Ayurveda deals Plaque psoriasis as *Ek-Kuṣṭha* [EK]with vitiated *Kaphā- Vāta Doṣas* predominantly and clinical features includes *Asvēdanam* [~anhydrosis] *Mahāvastu* [broad based], *Maṇḍalālotpatti* [~Round patches], *Ṛukṣa* [Dry], *Matsyaśākolapam* [Silvery scale like fish]. The Present case report will explore the efficacy of Ayurvedic treatment in management of *Ek-Kuṣṭha* [Plaque Psoriasis]

Patient and Methods
A moderately built 49 years old male farmer patient came in hospital with a complaint of elevated white-scaly skin lesions present on both upper and lower limbs, abdomen, and external pinna of both ears since one and half years.

Case Details
He was also having severe itching over these lesions which was causing discomfort, and is disrupting his daily routine activities. He was apparently healthy before one and a half years. Firstly, he developed a small circular patch on his abdomen which later increased in number along with severe itching and white scaling. He took medicines for it and they got subsided for a while. But in February 2023, he developed the same complaints for which he consulted a dermatologist and was later diagnosed with psoriasis. He was prescribed medicines like corticosteroids, anti-histamine, and local ointments for 3 months. but recurrence of symptoms was seen when the medicines were stopped. Hence, he came to in our hospital for Ayurvedic management.

Clinical Findings
On examination, his general condition and nourishment were moderate. He was afebrile and his blood pressure, heart rate and respiratory rate was within normal limits. On systemic examination no abnormality was found in the cardiac, respiratory and central nervous system.

Dermatological Examination
Lower Limbs: Generalized severe pruritic, whitish plaque lesions overlapped with irregular marginated scaly eruptions on both lower limbs.
Upper Limbs: Generalized moderate pruritic, whitish plaque associated with scaling more on extensor side of both upper limbs.
Back: Patchy mild pruritic lesion with small size comparatively
Abdomen: Large pruritic plaque lesion mostly below the umbilical with scaling.
Diagnostic focus
Patient was diagnosed case of Psoriasis in March 2023 but no any relevant data available. Further reports were not done due to financial problem. So based on the clinical features he was diagnosed as *Ek-Kuṣṭha* [~Plaque Psoriasis]
Therapeutic Interventions
The intervention was adopted in the form of Ayurvedic oral medication and topically along with purificatory measures based on status of *Doṣas*. Initially, patient's primary complaints were unable to sleep at night due to itching over the abdomen and both upper-lower limbs. Suggestive of vitiation of *Kaphā* and *Rasa-Rakta.* Also, his dry scaly

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plaques pointed involvement of *Vāta* and *Māṃsa* [~Muscle tissue]. and involvement of area is more [Figure 1, Before Treatment] so the condition was assessed as EK with *Bahu-doṣa āvastha* [Involvement of more morbid Doṣas] of *Vāta-Rasa-Māṃsa-Kaphā* Predominance. Thus, the Ayurvedic principle of *śodhana* [Purificatory measures] along with *Āmpāchana*, [~Detoxification of metabolic toxins] *Kuṣṭhagna, Kaṇḍugna* [To relieve itching] and *Raktaśodhaka* [blood purifier] was adopted. The whole treatment strategy was planned for 70 days under 5 different stage including hospital stay around for 26 days. [Stage2 and stage 3]. Initially in stage 1, [Table 1] *Mañjiṣṭādi Kaṣāya* is a popular medicine for *Kuṣṭha* among ayurvedic clinicians. It has *Kaphā-pitta Śamaka, Rakta Śodhaka* [blood purifier] and *Āmpāchana* properties. [6] *Nimbādi Guggulu* which also has *Kaphā Vāta Śamaka* [~alleviation of *Kaphā Vāta Doṣas*] action and most of its ingredients possesses the *Tikta-Kaṣāya rasa*, [Bitter- astringent in taste] helps in relieving the itching. [7] *Nimbādi* and *Karañja Taila* has the *Kuṣṭhagna* and *Kaṇḍugna* properties and also helps as moisturizer. [8] and After 15 days, there were mild reliefs in itching, but no improvements in lesions were seen. Due to *Bahudoṣa āvastha*. and severity of symptoms, *Vāmana* and *Virechana* therapies were chosen in stage 2 and stage 3 respectively. For *Vāmana*, [Stage2] treatment protocol was planned as *Dīpana, Pāchana* with *Āmpachaka Vati* 500 mg twice in a day and *Muṣṭa*, [Cyperus rotundus] *Suṇṭhi Churna* [Zingiber officinale Powder] 10 gm in 2 litre of warm water as a drinking water for whole day for 3 days. After assessing proper *Nirāma Lakṣaṇa*.[~ Optimal digestion symptoms] and then patient was given *Snehāpāna* [internal oleation] with *Pañcatikta Ghṛta* [medicated ghee] in increasing dose starting from 50 ml to 140 ml [Table 1, Stage 2] followed by *Sarvāṅga Abhyaṅga* [Whole body oil massage] and *Bāṣpa Sweda*.[~ Sudation] On the 2nd day in the early morning around 7:00 AM after *Sarvāṅga Abhyaṅga* and *Bāṣpa Sweda, Vāmana* therapy were done, and *Madhyama Śuddhi* [medium bio purification*]* was observed. Accordingly, for 5 days, *Sansarjana Karma* [Special dietetic schedule] advised. In stage 3 [Table 1] domain, *Virechana* were planned and for that *Aam-Pāchana* was performed for 2 days with *Muṣṭa śuṇṭhi jala* in prescribed dosage. *Snehāpāna* with *Pañcatikta Ghṛta* with dose of 50 ml, 100 ml, and 150 ml based on his digestive capacity. For three days*, Sarvāṅga Abhyaṅga* and *Bāṣpa Sweda* were done, followed by *Virechana* with 50 gm *Trivruta lehyama. Sansrajana karma* [Special dietary schedule] was also performed for four days in accordance with *Madhyama Śudhhi.* Later, patient was discharged from the hospital with oral and topical Āyurvedic medicines for 7 days. Then patient came for follow-up after 7 days, all clinical features were significantly improved; however, some skin discoloration at lesion site still left. [Figure 1, After Treatment] Thus, *Mañjistādighana vati as a Raktaśodhaka* [Blood Purifier] was prescribed, and lotion were advised as per the requirement of affected area.*"*

RESULT

During each follow up the patient improved. But after the *Vāmana,* [Therapeutic emesis] itching were reduced but there was still some itching during night and scaly lesions showed mild response, directed need of more *Śodhana* [Bio purification] so in stage 2 *Virechana* [Therapeutic purgation] were planned, he stated that itching had completely subsided, the presence of scaly lesions had significantly decreased, and only skin discolouration at lesion site were remained so in further follow up he treated with oral and topical ayurvedic medication. [Table1, Stage 3 and 4] detailed outcome is assessed through the subjective criteria, [10] [Table 2] photographic evidence [Figure 2] and PASI [Psoriasis Area Severity Index] Score. [11] [Table 2]

DISCUSSION

Psoriasis, an enigmatic and multifaceted chronic inflammatory skin disorder and it goes beyond its visible manifestations, impacting not only the skin but also the overall quality of life of those who bear its burden. [12] Current psoriasis treatments encompass topical agents, phototherapy, systemic therapies [including biologics], and emerging small molecule inhibitors. While these offer relief, limitations persist. Topicals target localized areas, and long-term use can lead to skin thinning or systematic side effect. [13] Phototherapy demands frequent clinic visits and carries skin cancer risks. [14] Systemic therapies may have side effects and Biologics provide efficacy but come with high costs and infection risks. Thus, an effective alternate treatment is necessary for Psoriasis.

In Ayurveda, EK comes under the umbrella of *Kuṣṭha.* It is primarily attributed to an imbalance in the *Vāta* and *Kaphā Doṣas*, often accompanied by vitiation of *Rakta Dhātu* [blood tissue] these imbalances lead to specific symptoms based on the predominance of these Doṣas and involvement of *Dhātu.* [15] Its ayurvedic management involves *Śodhana* [detoxification] therapies to eliminate vitiated *Doṣas* followed by *Śamana* [Pallative] therapies to balance the *Doṣas* and restore the skin health.

In the current case of *EkKuṣṭha* [Psoriasis] characterized by a predominance of *Vāta* and *Kaphā Doṣas*, coupled with *Bahudoṣa āvastha*. In response, a treatment approach involving sequential *Śodhana* [detoxification] followed by *Śamana* [balancing] therapies was selected. *Panchiktaka Ghrita,* the medicated ghee administered during *Snehāpāna*, possesses *Vāta Kaphā hara* properties akin to the chemical and physiological composition of both ghee and the human cell membrane. This synergy enhances the penetration of *Sneha* [ghee] into the tissues, facilitating partial rejuvenation of cells. [16,17] Furthermore, it aids in the elimination of excessively vitiated *Doṣas* from the *Śākha*, promoting the smooth transfer of *Doṣas* from the *Śākha* to the *Koṣṭha*, subsequently expelling them through the processes of *Vāmana* and *Virechana*. *Abhyaṅga* and *Swedana* were administered to support the aforementioned *Śodhana* process, while *Nimbādi Taila* and *Karañja Taila* exhibits *Kuṣṭhagna* properties as well as *Vraṇāropana*, *Śothahara* [anti-inflammatory], and *Tridoṣahara* [18,19]. Through these qualities, coupled with the oil's moisturizing and emollient effects, they may alleviate itching, dryness, and helped in elimination of lesion scaling. *Pañcatikta Kaṣāya* [20] and *Ārogyavardhini Vati*, [21] mentioned in Ayurvedic texts as *Kuṣṭhagna* medicines, exhibit anti-inflammatory, immunomodulatory, anti-histaminic, and anti-microbial properties. *Gandhaka Rasāyana* [22] act as *Agnīdīpaka, Pācaka, Rasāyana, Kaphāgna, Krimighna, and Raskaprasādaka* thus it aids in management of EK. Cadipsor ointment is a dermatological Ayurvedic Proprietary formulation, created from *Charmarognāśaka taila*. [Oil which having skin disease healing properties] This ointment effectively alleviates itching, while also providing moisturization for the skin.

CONCLUSION

This case study highlights the promising results of a personalized ayurvedic treatment in Psoriasis, which offers insights into future directions for skin disorder management. The combined protocol of *Shodhan* and *Śamana* appears potent for EK management. For further studies, randomized clinical trials are required to be done to assess ayurvedic sustained benefits in different chronic skin conditions.

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Table 1. Treatment plan adopted

Stage 1 *Śamana Aushadhi* [Palliative care]			
Nimbādi Guggulu	1 gm thrice a day	Orally after food	LW
Mañjistādi Kaṣāya	30 ml twice a day	Orally before food	LW
Ārogyavardhini Vati	500 mg twice a day		LW
Nimba + Karañja Taila	Q.S.	Orally after food Topical application	
Stage 2 *Vāmana* [Therapeutic emesis]			
Āmpāchana for 3 days			
Āmpachaka vati	500 mg twice a day	Orally before food	LW
Muṣṭa+ shuthi churna	10 gm in 2 liter of water		LW
Snehāpāna [Internal oleation] for 4 Days		As drinking water	
Pañchtikta ghṛta	30 ml, 60ml, 100 ml and 140 ml for consecutive 4 days		LW
Sarvānga abhyanga -Swedana for 2 days	45 minutes *Abhyanga* and 10 minutes *Swedana*	Orally in early morning	
Nimb tail + Karañja Taila			
Vāmana Karma			

• Luke warm milk	1500 ml		
• *Madanphala [Randia dumetorum]+Vacha* [*Acorus calamus*] + Rock salt + Honey	5gm + 1 gm+ 3 gm + 15 ml		
• *Yaṣṭimadhu Phanta* [Infusion of *glycyrrhiza glabra*]	1600 ml	Orally Orally	
• Rock salt water	400 ml	Orally	
Sansarjana Karma [Special dietetic schedule]	For 5 days	Orally	
Stage 3 *Virechana* [Therapeutic purgation]			
ĀmPāchana for 2 days *Muṣṭa + Shunthi churna*	10 gm in 2 litres of water	As drinking water	LW
Snehāpāna for 3 Days *Pañchtikta ghṛta*	50 ml, 100 ml, 150 ml for consecutive 3 days	Orally in early morning	LW
Sarvāṅga Abhyaṅga swedana for 3 days *Nimbādi Tail + Karañja Taila*	45 minutes *Abhyaṅga* and 10 minutes *Swedana*	Whole body	
Virechana Karma *Trivruta Lehyama*	50 gm with 100 ml of *Triphala Kashya*		LW
Sansarjana Karma [Special dietetic schedule]	For 4 Days	Orally	
Stage 4 *Śamana Aushadhi* [Palliative care]			
Pañchtikta Kaṣāya	30 ml twice a day	Orally	LW
Ārogyavardhini Vati	500 mg twice a day	Orally	LW
Gandhaka rasāyaṇa vati	500 mg twice a day		
Cadipsor ointment	Q.S.	Topical application	
Stage 5 *Śamana Aushadhi* [Palliative care]			
Mañjistādi Ghana vati	500 mg twice a day	Orally	LW
Cadipsor ointment	Q.S.	Topical application	

LW – Lukewarm Water

Table 2. Subjective criteria and PASI Score

Clinical Features	Parameters	Grade	Stage 0	Stage 1	Stage 2	Stage 3	Stage 4
Asvedanam [~anhydrosis]	Normal sweating	0	0	0	0	0	0
	Mild sweating	1					
	Mild sweating after exercise	2					
	No sweating after exercise	3					
Mahāvastu [broad based]	No lesions on body	0					
	Partial lesions on hand, leg, neck, scalp, trunk, back	1				1	1
	Lesions on most parts of the hand, leg, neck, scalp, trunk, back	2	2	2	2		
	Lesions on all parts of body	3					
	Lesions on the whole-body	4					
Matsya-Śakalopamam	No scaling	0					

Parameter	Grade	Score					
[Silvery scale like fish]	Minimal [occasional fine scale over < 5% of the lesion]	1				1	1
	Mild [fine scale predominates] 2	2			2		
	Moderate [coarse scale predominates]	3					
	Marked [thick, non-tenacious scale predominates]	4	4	4			
	Severe [very thick, tenacious scale predominates]	5					
Kṛṣṇa aruṇa varṇa. [Dark colour]	Normal colour 0	0					
	Near to normal, this looks like normal colour [faint]	1					1
	Light reddish colour	2		2	2	2	
	Moderate red colour	3	3				
	Bright red colour	4					
	Dusky to deep red colour	5					
Kaṇḍu [Itching]	No itching	0				0	0
	Mild itching [only aware of itching at times, when relaxing]	1					
	Intermediate between 1 to 3	2			2		
	Moderate [sometimes disturbs the sleep and day time activity]	3					
	Intermediate between 3 and 5	4		4			
	Severe [constant itching, frequent sleep disturbance]	5	5				
Rukṣata [Dry]	No line on scratching with nail	0				0	0
	Faint lines on scratching with nail	1			1		
	Lines and even words can be written on scratching by nail	2					
	Excessive *Rukṣata* leading to Kandu	3	3	3			
	Rukṣata leading to crack formation	4					
TOTAL SCORE			17	15	9	4	3
PERCENTAGE OF RELIEF				11.7%	47.0%	76.7%	82.5%

		Before Treatment	After Treatment
PASI SCORE		**20.6**	**0.9**
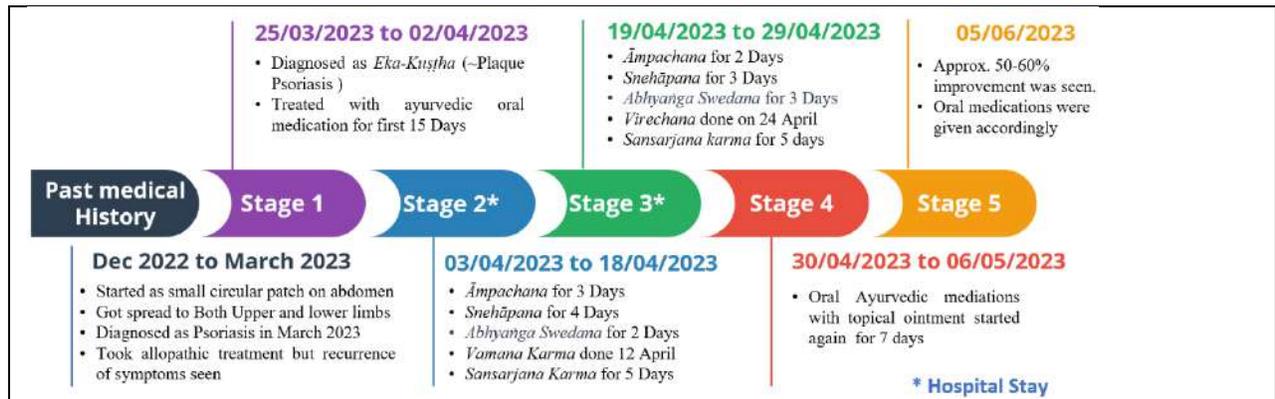
Figure 1. Timeline of the case

Figure 2. Before and After treatment

RESEARCH ARTICLE

An Investigation of Water Quality and Planktonic Diatoms of Pallikaranai Wetland

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ABSTRACT

Wetlands are the connecting link between the land and water. They are considered to balance the ecosystem as they are productive with diverse biological organisms. Pallikaranai marsh is an urban wetland of Chennai which shows the importance of species diversity and water quality management. In this study various physico chemical parameters of water body was analyzed and phytoplankton study was reported. Phytoplankton is the key tool to assess the water quality status of any ecosystem. By observing the phytoplankton community, dominant pollution indicator species such as Nitzschia, Navicula and Synedra, were reported along with the other species. Nutrient status of the aquatic system showed high eutrophication levels. The study shows the urgent need to monitor and conserve the wetland from anthropogenic activities and nutrient load.

Keywords: Wetland, Diatom, Phytoplankton, Pallikaranai, Water quality, Ecosystem

INTRODUCTION

Wetlands are defined as transitional areas of land covered by saturated water for varying periods of time [1]. It is estimated that freshwater wetlands alone support 20 percent of the known range of biodiversity in India [2]. They occupy 58.2 million ha in India, including areas under paddy cultivation [3], however development in urban areas has led to the loss of more than 60% of national wetlands [4]. The influence of physical factors such as temperature, salinity, pH, nitrate, nitrite, ammonia and silicate on the phytoplankton community alters species composition and their diversity in the marine ecosystem [5, 6]. The qualitative and quantitative studies on phytoplankton have been utilized to assess the quality of water [7, 8]. Phytoplankton, especially diatoms, respond rapidly to the changing physico-chemical conditions of the aquatic environment coupled with the varying nutrient content [9, 10]. The distribution of phytoplankton varies considerably with respect to different seasons and pollution load. They are the primary producers in most of the aquatic ecosystems and regarded as important food and energy sources for other organisms [11, 12]. They also play an important role in maintaining the biological balance and quality of water [13]. Their biological effects and prediction of impacts are helpful in restoration measures for reversing the process of eutrophication in water bodies. The necessity of using phytoplankton as an effective and appropriate method of bio monitoring for evaluation of water quality has been emphasized [14].

Bio-indicators can be defined as "living organisms including microorganisms, plants and animals which are used to measure the healthiness of the natural habitat". The environmental pollution can be measured using the phytoplankton community because they are the best indicators [15]. Diatoms are widely used for monitoring environmental contamination and serve as bio-indicator of water quality and pollution status [16]. Diatoms, considered as one of the major, diverse and ecologically important phytoplankton groups, form nearly 20% of global primary productivity [17]. Most importantly, diatoms are the primary producers of any aquatic ecosystem [18, 19]. They are the major component and dominant life form of the phytoplankton community. However, in India, very few reports correlated diatoms with water quality and community analysis [20, 21, 22]. They are an important indicator of environmental changes where individual species respond directly or indirectly and sensitively to changes in chemical, physical parameters [23]. The siliceous bodies of diatom have a long history of exploitation and acquire many features valued in ecological indications and extended their uses in various fields [24]. They are used extensively in palaeo-ecological studies because they are excellent indicators of past environmental conditions. Phytoplankton serve as bio-indicators with reference to water quality and thus serve as a tool for assessing the health of the aquatic ecosystems. Studies on planktonic composition and physico-chemical characteristics of water are necessary to acquire basic knowledge on the biodiversity status of any water body. Hence the present study was undertaken to know the influence of physio-chemical parameters of water on phytoplankton, especially the diatom diversity in Pallikaranai Marshland. Pallikaranai marsh is one of the few natural coastal aquatic habitats of India with diverse species of flora and fauna. This study attempts to determine the water quality conditions and phytoplankton composition status of the wetland ecosystem and also helps to understand the interaction between physicochemical parameters of the water and phytoplankton diversities of Pallikaranai marsh during the summer.

METHODS AND MATERIALS

Study Area
Pallikaranai marshland is the only urban wetland of Chennai city located near the Coromandel Coast at the south side of the Adyar estuary bound by Velacherry in the North, Kovilambakkam in the West and Okkiyum Thoraipakkam in the East and its catchment area is nearly 235 square kilometres. Athough a vast portion of the marsh was declared as a reserve forest in 2007 under the Tambaram forest range department, ironically these protected lands are being encroached for urban development.

Field Water Sampling

Duplicates of water samples were collected from the field site to understand the water quality variables like pH, salinity, total dissolved solids, water temperature and dissolved oxygen were measured. The samples were collected early in the morning and transported to the laboratory and analysed for nitrates, inorganic phosphates/or phosphorous, total hardness, chlorides, alkalinity

Analysis of Physio-chemical Parameters in Water Sample

Water samples were collected from Pallikaranai marshland in the month of february 2023. One litre polypropylene bottle which was previously cleaned, rinsed and washed with distilled water was used for collection. The water samples were analyzed for physio-chemical parameters viz., Colour, Odour, pH, DO, Alkalinity, Hardness, Chloride, Total dissolved solids (TDS), Fluoride, Iron, Ammonia, Nitrite, Nitrate, Phosphate and Residual chlorine using field water testing kit purchased from TWAD (Tamil Nadu Water Supply and Drainage Board) Chennai. The kit used were of precise accuracy and the chemicals used were listed in the Table. 1. All the analyses were done in duplicates. The final values were expressed in milligram/litre.

Nutrient Analysis

pH

The pH of the water was tested using the pH paper and the colour intensity was compared with the pH chart and the values were recorded.

Dissolved Oxygen

DO was done according to Winkler's method. 1 ml of Manganese chloride and 1 ml of Alkaline Iodine was added to the water sample and made to settle down. 1 ml of conc. sulphuric acid was added to the solution and slowly the reagent bottle was shaken to mix the contents well. Further 50 ml was drawn from the reagent bottle into a conical flask and titrated against Sodium thio sulphate using starch as an indicator. The end point is the disappearance of blue colour and the corresponding burette reading was noted and calculated accordingly.

Alkalinity

20 ml of water sample was taken in a beaker and 5 drops of AL1 solution was added to it which changed the colour of the sample to blue. AL2 was taken upto the mark of 40 in a syringe and was added drop by drop to the beaker containing sample. The sample turned into an orange colour. Its corresponding markings present in the syringe was noted and calculated for the total Alkalinity by multiplying with 10.

Hardness

20 ml of water sample was taken in a beaker and 5 drops of TH1 solution was added to it. After the addition of TH1 the sample turned into wine red colour. Then TH2 solution was taken up to the mark of 40 in the syringe and added drop by drop into the beaker. Colour changed from wine red to blue colour was observed. After it changed to blue colour the final marking was noted down and calculated for the total hardness by multiplying with 10.

Chloride

20 ml of water sample was taken in a beaker and 5 drops of CL1 solution was added to it. The sample turned into a lemon yellow colour. After this CL2 solution was added drop by drop which was filled up to the mark of 40 in the syringe. The solution then turned into brick red. The colour change and its corresponding markings on the syringe was noted. Total chloride content was calculated by multiplying the value with 10.

Fluoride

5 ml of water sample was taken in the given glass bottle and 5 drops of FL solution was added and gently shaken. The colour change was compared with the standard colour chart provided in the kit and the values were recorded respectively.

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Ammonia
10 ml of water sample was taken in the given glass bottle and 5 drops of AA solution was added to it and gently shaken. The sample was observed for any change in colour and corresponding values were recorded according to the standard colour chart.

Nitrite
10 ml of water sample was taken in the given glass bottle and 2 drops of NO_2 solution and 2 drops of NO_3 solution was added and shaken well. The colour change was compared with the standard colour chart and the values are noted down.

Nitrate
9 ml of water sample was taken in the given glass bottle and 1 ml of distilled water was added to it. Mixture of NO1 was added using the given spatula and 2 drops of NO_2 and 2 drops of NO_3 were added and gently shaken. The colour change was compared with the standard colour chart and the values were noted.

Iron
10 ml of water sample was taken in the given glass bottle and 5 drops of IR1 solution, 1 drop of IR2 and 5 drops of IR3 solution was added and shaken well. The sample was kept undisturbed for 5 to 10 minutes until the turbidity turned into a clear solution. Presence of any colour change was compared with the standard colour chart and the values were noted.

Phosphate
10 ml of water sample was taken in the given glass bottle and 5 drops of PO1 solution and 1 drop of PO2 solution was added. The colour change in the sample was compared with the standard colour chart and the values are noted.

Residual Chlorine
10 ml of water sample was taken in the given glass bottle and 5 drops of RCL solution was added and gently shaken. The colour change in the sample was compared with the standard colour chart and the values were noted.

TDS
Total Dissolved Solid value was calculated by adding the total alkalinity, total hardness and chloride values and then multiplying it with 1.3.

Diatom collection and Identification
The collection of Diatom samples have been done by using plankton net of 200 μm mesh and the samples have been preserved simultaneously by adding formaldehyde (4%) and allowed to stand for 24 hours. The samples were then transferred to the laboratory for observation and identified following taxonomic literatures [25, 26,27].

Microscopic Study of Diatoms
The samples were centrifuged and thoroughly rinsed to remove any debris and about 0.5 ml of sample was transferred to a clean microscopic slide for observing the diatom morphology under the Stereomicroscope at a magnification of 40x and 60x respectively (Fig. 3, 4 & 5)

RESULTS AND DISCUSSION

The water quality parameters which were analyzed from Pallikaranai wetland waters are shown in the Table. 2 with the standards of each. The following graph (Fig. 6) shows alkalinity (380 mg/L) was very high followed by total hardness and chloride levels at 250 mg/L. Very low amount of fluoride levels were recorded in the site at 1.5 mg/L

Diatoms are photosynthetic and commonly seen in golden brown, abundant in both freshwaters as well as the marine environment [28]. The diatom cell is known as frustules and its characteristic feature is possession of a silica cell wall. This structure is highly ornamental, which is species specific and often used as means of identification. It is composed of two overlapping halves like a pill box or a pair of petridish. Diatoms are divided into order centrales and pennales based on symmetry[29]. Table 3 shows the list of diatoms identified up to genus level in the Pallikaranai wetland The abiotic components give information about the type of a substance or pollutants and its concentration, while biological components show the degree of ecological imbalance, which has been caused. Growth, oxygen demand, food requirements and food conversion efficiency of the various biotic communities are directly affected by the temperature **[30]**. Many researchers proved that aquatic organisms are affected by pH since most of their metabolic activities are pH dependent [31, 32]. The pH was high in the water sample indicating high alkaline nature. Toxicity increases as the pH and temperature increases and we could see both were in increased levels in the site. Dissolved oxygen was very low in the wetland which may affect the growth of fish and lead to fish mortality. High amount of total hardness in the sample is resultant impact could be due to regular addition of domestic sewage, and detergent which has increased the hardness of water in the site. The high amount of chloride ions is an important indicator suggesting organic pollution. Phosphate is an important nutrient maintaining the fertility of the water body. High phosphate levels in the summer shows the eutrophication status of the water body. From the inferred results, it can be concluded that groundwater around Pallikaranai marsh possesses high values of TDS, anions and cations which make the water non-potable and the operation of dumpsite from Perungudi is mostly responsible for accelerating the groundwater contamination in the area. Increased concentration of ammonia was reported may be due to the incursion of terrestrial runoff and decomposition of phytoplankton **[33, 34].** Increased ammonia content may alter or change normal tissue, development of gills, liver and kidneys of fishes.

The phytoplanktonic study is a very useful tool for the assessment of water quality in any type of water body and also contributes to understanding of the basic nature of lakes **[35].**Phytoplankton species can be very sensitive to slight modification in its environment and hence, it provides good insight about water quality before it reaches extreme visible conditions like eutrophication **[36].** In this study phytoplankton assemblages were reported in the wetland waters with abundance in the Bacillariophyceae group. Diatoms are one of the most important and interesting groups of phytoplankton. The assemblage of diatoms reveals the quality of the aquatic environments. The alkaline condition of water could also influence the diatom abundance. Many diatom species such as *Gomphonema, Nitzschia, Melosira, Stauroneis, Caloneis, Cyclotella, Synedra, Cymbella,* and *Fragilaria* are reported to be indicators of the high nutrient conditions [37].According to the study by **[38]** a number of pollution indicator genera such as *Navicula, Nitzschia, Cymbella* and *Melosira* were documented in the study. Due to a lot of growing problems, degradation of the wetland ecosystem has necessitated the monitoring of water pollution and water quality to evaluate their production, capacity, utility potential and to plan restoration measures. The quality of any water can be analyzed by the changes in the physico-chemical and biological properties. The values of certain parameters are giving us an alarm towards its pollution level. With the industrialization, increasing population and anthropogenic factors there is an urgent need of continuous monitoring, conservation and scientific management of the wetland and to protect its biodiversity.

CONCLUSION

Water is the most abundant and renewable resource, which helps to maintain the earth's climate and dilute environmental pollution. The present study incorporates the various physico-chemical aspects and biological components of the Pallikaranai wetland. Dominant species such as *Nitzschia, Navicula* and *Cymbella* can be used as a pollution indicator to monitor and evaluate the lotic and lentic water bodies. However, further studies are needed to focus on the seasonal variation of diatom species, in addition to the water parameters for the better conservation and management of the wetland ecosystem.

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Table.1 List of Chemical Reagents in the Test Kit

SAMPLES	SOLUTION
AL1	Brown Cresal Green Sodium Salt, Methyl Red Sodium Salt
AL2	H_2SO_4 (Sulphuric Acid)
TH1	HCL (Hydrochloric Acid), Amino ethanol, Magnesium salt EDTA

TH2	Calmagite indicator
TH3	Sodium Salt dihydrate, EDTA
CL1	Potassium chromate
CL2	Silver Nitrite
FL	Zirconium oxychloride, Xylenol orange indicator
AA	Mercuric iodide red, Potassium iodide, Sodium hydroxide pellets
NO2	Sulphanilamide, Orthophosphoric acid
NO3	N-1 Naphthyl, Orthophosphoric acid
IR1	Hydrochloric acid (HCL)
IR2	Hydrogen peroxide
IR3	Ammonium Thiocyanate
PO1	H_2SO_4, Ammonium molybdate
PO2	Stannous chloride
RCL	Ortho tolidine, HCL

Table. 2 Physico-chemical Parameters analysed from Pallikaranai Wetland

S. NO	PARAMETERS	END POINT(COLOUR)	END POINT VALUE	STANDARD VALUE
1.	Colour	Unclear	-	-
2.	Odour	Pungent	-	-
3.	Temperature	-	28°C	-
4.	Ph	>7 alkaline	8	6.5-8.5
5.	DO	Disappearance of dark blue colour	2.56	5.5
6.	Alkalinity	Yellow- Red colour	380 mg/L	600 mg/L
7.	Total Hardness	Blue colour	250 mg/L	600 mg/L
8.	Chloride	Brick red colour	250 mg/L	1000 mg/L
9.	Fluoride	Light shade of pink	1.5 mg/L	1.5 mg/L
10.	Ammonia	Dark orange	>5 mg/L	0.5 mg/L
11.	Nitrite	-	-	-
12.	Nitrate	-	-	45 mg/L
13.	Iron	-	-	1.0 mg/L
14.	Phosphate	Dark blue	>5 mg/L	-
15.	Residual chloride	Light shade of yellow	0.1 mg/L	0.2-1.0 mg/L
16.	Total TDS	(TA+TH+Chloride)1.3	1144 mg/L	2000 mg/L

Table. 3 List of Diatoms Identified from Pallikaranai Wetland Waters

S.No	Diatom (Genus level)
1.	Fragilaria
2.	Synedra ulna
3.	Navicula
4.	Amphora
5.	Nitzschia
6.	Nitzschiaclosterium
7.	Synedra
8.	Gomphonema
9.	Brachysira
10.	Cymbella
11.	Gyrosigma
12.	Pleurosigma
13.	Achnanthes
14.	Neridium
15.	Pinnularia
16.	Diploneis
17.	Tabularia
18.	Frustulia
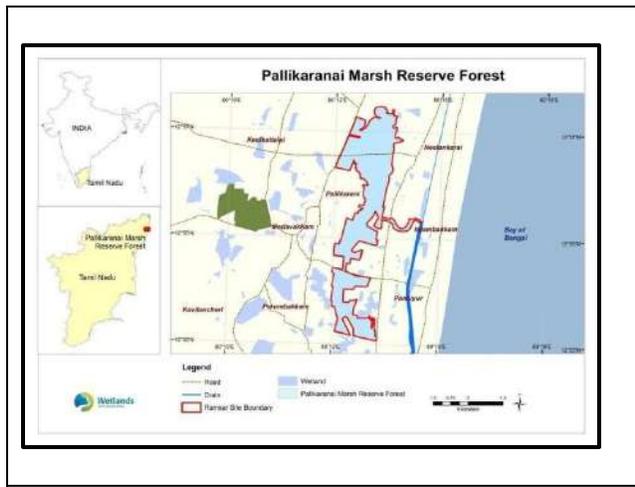
Fig.1 Pallikaranai Marshland Map	Fig.2 Sample Collection Site

Fig. 3 Pennate Diatoms in 40X Magnification

Fig. 4   Image showing numerous Nitzschia species observed under 40X Magnification

Fig.5 Image of Diatom at 60X Magnification
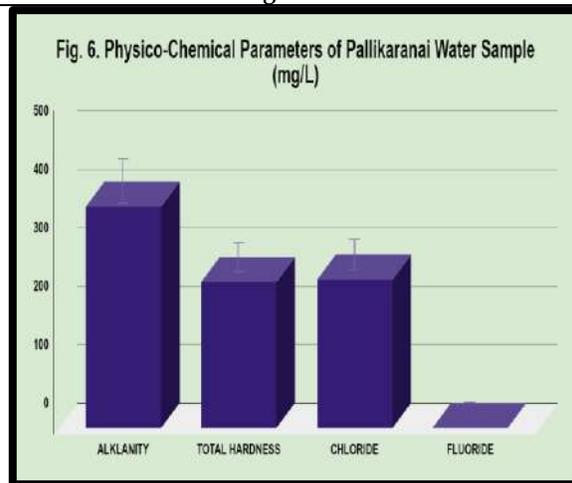
Fig.6 Physico-chemical paramaters of pallikaranai water sample(mg/l)

RESEARCH ARTICLE

Effects of Lichen Growth on Some Monuments of Rajasthan, India

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ABSTRACT

This paper reports the consequences of the lichen growth on some architectural structures of monuments in Udaipur, Bharatpur, Jaipur, districts of Rajasthan studied with the help of electron microscopy and petrography methods. Two lichen species *Phylliscum indicum* and *Leprocaulon coriense* were selected for SEM-EDX, and for petrographic studies one epilithic lichen *Endocarpon subrosettum* growing on brick, and one endolithic lichen *Naetrocymbe saxicola* growing on marble were selected. Epilithic and endolithic growth were seen in petro graphic slides, and in SEM-EDX, mineral particles along with peaks of various elements is visible

Keywords: Bio deterioration, Electron microscopy, Lime plaster, Lithobiont, Petrography

INTRODUCTION

The colonization of the lithobiontic community depends on the relationship between the monument's construction material and environment [1]. The lithobiont known to affect the durability of cultural heritage stones [2]. Lichen is one of them and has long been known to cause bio deterioration [3],[4]. However, the process of bio deterioration occurring in nature ever since life originated on the earth, but this area of research drew the attention of researchers only in the mid-20th century [5],[6],[7],[8],[9],[10],[11],[12],[13], [14],[15]. It is evident that microorganisms cause both physical and chemical damage [16], [17],[18]. Lichens are known to secrete various secondary metabolites, of these, oxalic acid is predominantly known to cause the bio deterioration of stones. Moreover, lichens producing carbonic acid as a consequence of respiration, contraction and expansion of the lichen thallus by absorption and desorption of

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moisture is another strong bio deterioration as well. The bio deterioration by *lichen* has been analyzed by using various techniques like SEM (scanning electron microscopy), SEM-EDX (scanning electron microscopy equipped with energy dispersive X-ray), TEM (transmission electron microscopy), AAS (atomic absorption spectroscopy), IR (infrared spectroscopy), etc. [19],[20],[21],[22],[23]. Monuments are the representatives of our history and culture, and are built with the help of various types of construction material like stones, marbles, granites, lime, mud etc.[24],[25],[26],[27]. In this study, we tried to estimate the effect of lichen growth on monuments with the help of SEM-EDX, and Petrography. The SEM + EDX not only gives microscopic images but also provides elemental analysis [28], and is also helpful in environmental monitoring studies, The petro graphs will provide the penetration of fungal mycelia in the substratum. This information will be helpful for assuring the bio deterioration and conservation of archaeological sites.

MATERIALS AND METHODS

Sampling
The lichens samples utilized in the present study were collected from the abandoned monuments, and road side structures in Jaipur, Udaipur, Bharatpur districts of Rajasthan during 2017 to 2019.

SEM-EDX
For SEM-EDX analysis, two samples *Phylliscum indicum* Upreti, and *Leprocaulon coriense* (Hue. Lendemer & B.P. Hodk) which were growing on the lime plaster. (JSM 6490LV) SEM equipped with an EDX (JEOL, Japan) utilized for the experiment. Samples were coated with Pt(Platinum) before the experiment.

Petrography
Petro graphic studies, two species, *Endocarpon rosettum* Ajay Singh & Upreti growing on brick and *Naetrocymbe saxicola* A.Massal & R.C.Harris on a lime plaster, were selected. Two substrata (a marble piece and a brick) were selected to estimate the hyphal penetration. Samples first embedded in resin, and prepared by following [29]. The thin cross sections of approximately 40 μm, petro graphic slides were investigated under electron microscopes.

RESULTS AND DISCUSSIONS

SEM – EDX
Various patterns of lichen growth could be observed (Fig.1), (A), (B), (C), (D),and (E). Here, (Fig.1) (A),(C),(D),(E), were epilithic lichen species while, (E) is endolithic species. All these species were growing on Calcium rich substratum. The hyphae within the substratum were also visible (Fig. 2) (A), that shows lichen species *Leprocaulon coriense* hyphae penetrating the lime plaster, and for this reason, the substratum provides a suitable environment for the lichen growth also. Therefore, both biological and non-biological agents like sunlight, air, rainfall play a role in the degradation of stones [30]. Some mineral particles are also visible. (Fig.2) (B), (C). In EDX (Fig. 3),(A),(B),(C) we can see the peaks of Ca, C, O, Al, Si, and Mg that represent the presence of calcium oxalate (Ca, C, O) [31].Carbonic acid, that is a consequence of respiration, and produced with the reaction of H_2O and CO_2, that show chelating activity and deteriorate the calcium-rich substrate, The peaks of Al Si and Mg shown in (Fig. 3) (A),(B),(C) represent that lichen colonization have positive correlation with its silica rich substratum. Some amount of Ti and, S also present in (Fig. 4) (B) that represents the presence of anthropogenic activity in the particular area. [22].

Petro graphic studies
In petro graphic images, in the case of epilithic lichens, apothecia of *Endocarpon subrosettum* can be observed on the upper surface of the brick (Fig.3). (A), (C), and spore-like structure are also visible in the middle part of the section (Fig.3), (D). While in the case of endolithic lichen, *Naetrocymbe saxicola* clear cavities are visible throughout the thin

sections (Fig.3), (B), (E). Hyphae are also visible through the thin section of marble (Fig.3), (F). In the case of endolithic lichen species that are growing in the marble cavities, which can be seen throughout the thin sections, these cavities are varied in their size (186.76μm- 707.18μm) and could be the result of chemical activities of lithobiont (Fig. 3), (B),(E). The colonization of endolithic lichen is very well distributed on the surface, and inside the stone as well. Moreover, the nature, and chemical composition of the substratum also play key role in the deterioration of it, if the substratum has loosely arranged particles in it then it will provide a good environment to the organisms as well [32].

CONCLUSION

There is not much information available regarding studies on bio deterioration of monuments by lichens in India. However, some researchers reported about bio deterioration on monuments in some states[33],[34],[35]. The present study on lichens causing bio deterioration will act as a baseline data that can be used as a useful tool for future lichenological studies on monuments in the study area, and helpful to develop conservation strategies of monuments, may also support bio monitoring studies [36],[37]. Although some studies report lichens as a bio-protective agents rather than bio-deteriorative [38], but role of lichens as a bio-deterioration or protector depends on many aspects like chemical composition, and texture of substratum and chemical compounds produced by lichen. Many conservation strategies such as treatment with plant extracts, chemical treatments have been suggested by researchers for the conservation of monuments [39],[40],[41]. Indian subcontinent is rich in ancient heritage of monuments thus there is a need of cost effective approach to deal with their bio deterioration problems.

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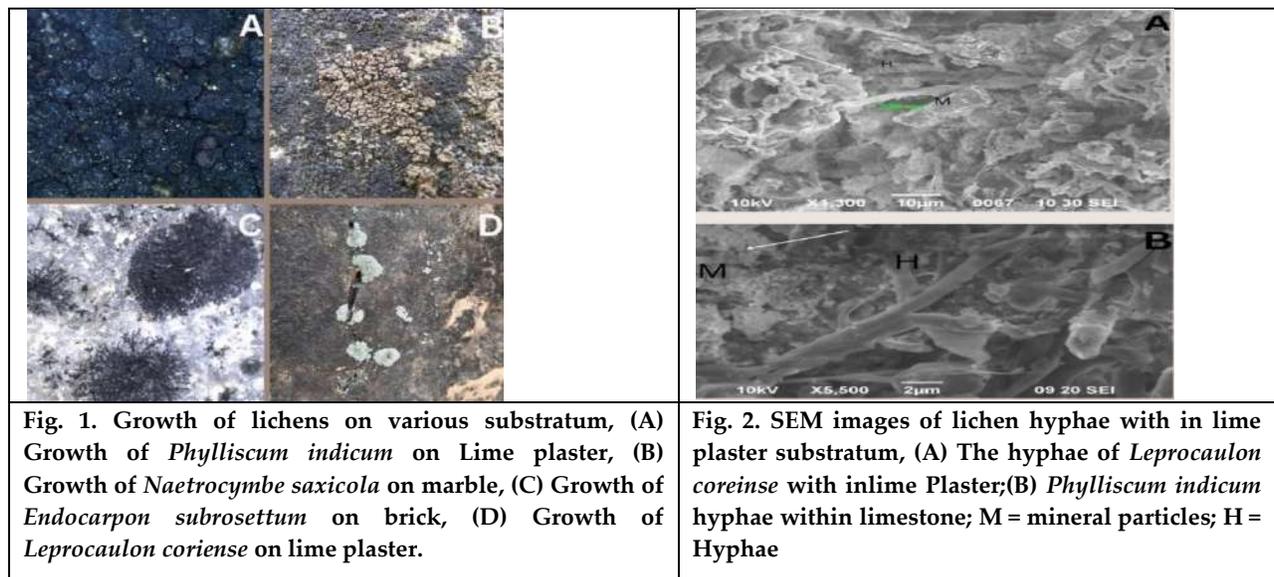
Fig. 1. Growth of lichens on various substratum, (A) Growth of *Phylliscum indicum* on Lime plaster, (B) Growth of *Naetrocymbe saxicola* on marble, (C) Growth of *Endocarpon subrosettum* on brick, (D) Growth of *Leprocaulon coriense* on lime plaster.	**Fig. 2. SEM images of lichen hyphae with in lime plaster substratum, (A) The hyphae of *Leprocaulon coreinse* with inlime Plaster;(B) *Phylliscum indicum* hyphae within limestone; M = mineral particles; H = Hyphae**

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Fig. 3. Petrographic analysis of brick, and marble. (A), Petrographic image of a brick with apothecia on the uppermost part (B), Image of marble with a cavity in it (C), Clear image of apothecia on brick Upper part (in circle), (D), Image of brick with hyphal penetration. and spore in the middle part of brick, (In circle) (E), Cavities in marble with some black coloured structure, (F), hyphal penetration in the middle part of the marble.	**Fig 4. EDX spectra of various species on calcareous substratum** (A), *Leprecaulon coriense* (Hue). Lendemer & B.P.Hodk,(B), *Phylliscum indicum* Upreti

RESEARCH ARTICLE

A Case Study: Regulatory Fit Theory to Measure the Employability Skill of Students Studying in Engineering Colleges in Tamil Nadu

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ABSTRACT

In order to improve the employability skills and make the students ready for industry, the government of Tamil Nadu has initiated Naan Mudhalvan massive up skilling platform. This platform enables the students to get training in the chosen field of interest and helps them to achieve their career goals. Various courses are offered particularly to the students of engineering colleges in Tamil Nadu. One such course is professional development course. In this course, the students are being taught Microsoft office fundamentals. In order to measure the effectiveness of this course, a study was conducted among the engineering college students of Tamil Nadu and regulatory fit theory was used to analyse the data. The study reveals that the students have benefitted by this course.

Keywords: Regulatory fit theory, Employability skill, Correlation Coefficients, ANOVA,SPSS software

INTRODUCTION

In India, both the central and state governments are taking serious efforts to bridge gap between the industry and the educational institution. Particularly, the Government of Tamil Nadu has initiated "Naan Mudhalvan" massive up skilling platform to make the students industry ready. Through this programme, the students of Engineering Colleges in Tamil Nadu are being taught varies courses, to say a few, AI &ML, Cloud Computing etc. These courses are offered via online mode or offline mode or in hybrid mode (online as well as offline). Every institution deputes one instructor to each course; industry person or expert first gives hands on training to course instructors. The

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instructors of courses concerned in turn monitor the students, help them to learn the course, to do assignments and projects. Some of these courses are mandatory and some are offered as value added courses. After successfully completing these courses, students can drop one or two professional or open elective papers and the credit earned through Naan Mudhalvan courses can be transferred and considered for awarding Degree to the student concerned according to the academic regulations. The professional development course is being offered in 3rd semester to engineering college students (Regulations-2021; Anna University) via online mode; through which the students are being taught Microsoft Office fundamentals. The purpose of this course is to make the students to learn and utilise Microsoft word document, Excel, Power point, Outlook, Access, Publisher and One note. The students can access the course contents which are recorded videos via the link provided to them. At the end of each session (some number of videos), the students have to do assignments and these are uploaded. At the end of the course, they have to submit a project assigned to them. The students were assessed by both the internal and external instructors and final score is calculated by the marks awarded by the instructors. As it is an online course and the score obtained by them can be transferred and considered for awarding Degree, it helps to know how students perceive the course and to measure the outcome of the course. A study among engineering college students was carried out for this purpose, and the regulatory fit theory was adopted. The data were analysed using SPSS software. As stated by the regulatory focus theory [1-2], there are two different motivational systems that control all goal-directed activity .Each of these two survival-related processes, referred to as promotion and prevention, has a specific purpose.

Promotion-focused people pay more attention to information about positive outcomes and favour eager strategies to gain advantages; prevention-focused people, on the other hand, typically pay more attention to information about negative outcomes and favour vigilant strategies to prevent potential losses [3].According to Wang et al. [4] intrinsic motivation serves as a bridge between promotion focus and creativity. Regulatory fit theory and cultural values orientation were applied by Chan et al. [5] to forecast the efficacy of public service advertising appeals. Yang [6] showed that the prevention regulatory focus fit strengthened the positive association between the prohibitive voice and safety performance evaluation. This finding is consistent with a considerable amount of literature and suggests that promotion focus can expand a person's attention and is helpful in acquiring of more extensive cognitive elements, which benefit fluency and flexibility [7-8]. According to the regulatory fit theory, a person who is more focused on advancement will be driven to reach important goals and be aware of opportunities for development. A person who is more concerned with prevention will be attentive to the occurrence of hazards and motivated to avoid security dangers. This relates to the requirement for regulatory fit. As a result, we suggest the two following hypotheses that are connected to the condition of regulatory fit:

H1: A person with a high promotion focus can perceive course material far more clearly than a person with a low promotion focus.

H2: A person with a strong focus on prevention will significantly better understand the course material than a person with a low focus on prevention.

MATERIALS AND METHODS

A total of 140 engineering college students currently in their 4th semester, in Tamil Nadu, were informed about the study. They were informed that the details will be kept in secret and those did not want to participate could withdraw from the survey. The questionnaires with three parts were distributed to the students:

Part-1 asks the personal details of the students like name, age, date of birth, branch of study etc.Part-2 contains the Regulatory Focus Questionnaire: six numbers of promotion focused questions and 5 numbers of preventive focused questions as in [3].Part-3 contains questions that ask the students about the level of knowledge they have acquired after this course such as: "After this course, your knowledge level in Microsoft word document" in 5-point scale ranging from 5 (Excellent) to 1(Not Satisfactory).Finally, 91 students responded, of which 53% are male and 47% are female. First the individuals were divided into 8 sub-groups as follows and for each group, correlation analysis was made between the scores obtained by the individuals in Part-2 and Part-3.

Group 1: Low Promotion Score and new to Microsoft Office Fundamentals.
Group 2: High Promotion Score and new to Microsoft Office Fundamentals.
Group 3: Low Promotion Score and not new to Microsoft Office Fundamentals.
Group 4: High Promotion Score and not new to Microsoft Office Fundamentals.
Group 5: Low Preventive Score and new to Microsoft Office Fundamentals.
Group 6: High Preventive Score and new to Microsoft Office Fundamentals.
Group 7: Low Preventive Score and not new to Microsoft Office Fundamentals.
Group 8: High Preventive Score and new to Microsoft Office Fundamentals.
Secondly, ANOVA tests were conducted to test the aforementioned hypotheses.

CORRELATION ANALYSIS

The Table1 shows the correlation coefficients between the individual's promotion score, preventive score and the subject score. It shows that there is a low positive correlation between promotion score and subject score and there is a very low negative correlation between preventive score and the subject score. Assuming that the promotion scores between 0 to 20 as Low Promotion Score (LPS), the correlation coefficient is found between the LPSs and the Subject Scores (Subs) of the individuals who were new to the course. Table 2 Shows that there is a very low negative correlation between them. Assuming that the promotion scores between 21 to 30 as High Promotion Score (HPS), the correlation coefficient is found between the HPSs and the Subject Scores (Subs) of the individuals who were new to the course. Table 3 Shows that there is a low negative correlation between them. From Table 2 and Table 3, it is seen that whether the promotion score is low or high, if the individual is new to the course, there is a negative correlation between the promotions score and the subject score. The correlation coefficient is found between the LPSs and the Subject Scores (Subs) of the individuals who were already familiar to the course. Table 4 Shows that there is a very low positive correlation between them. So, the individual motivated himself to learn further about the course.

The correlation coefficient is found between the HPSs and the Subject Scores (Subs) of the individuals who were already familiar to the course. Table 5 shows that there is a negligible correlation between them. Table 5 shows that the course does make any changes in the individual. Assuming that the preventive scores between 0 to 20 as Low Preventive Score (LPreS), the correlation coefficient is found between the LPreS and the Subject Scores (Subs) of the individuals who were new to the course. Table 6 shows that there is a moderate positive correlation between them. The correlation coefficient is found between the LPreSs and the Subject Scores (Subs) of the individuals who were already familiar to the course. Table 7 shows that there is a low negative correlation between them. Assuming that the preventive scores between 21 to 25 as High Preventive Score (HPreS), the correlation coefficient is found between the HPreSs and the Subject Scores (Subs) of the individuals who were familiar to the course. Table 8 shows that there is a perfect positive correlation between them.

ANOVA

ANOVA Test 1

Subject scores of 6 individuals with high promotion score and subjects scores of 8 individuals with low promotion score are taken. ANOVA test for single factor is conducted at 5% level of significance and displayed in Table 9 and Table 10. Since P-value(0.740683) is much higher than $\alpha = 0.05,$ we have to discard our hypothesis that a person with high promotion focus will perceive the content of the course more effectively than a person with low promotion focus in a significant way.

ANOVA Test 2

Subject scores of 2 individuals with high preventive score and subjects scores of individuals with low preventive score are taken. ANOVA test for single factor is conducted at 5% level of significanceand displayed in Table 11 and Table 12. Since P-value(0.624195) is much higher than $\alpha = 0.05,$ we have to scrap our hypothesis that a person with

high prevention focus will perceive the content of the course more effectively than a person with low prevention focus in a significant way.

CONCLUSION

In the present study, the ANOVA test for 1 factor at 5% level of significance reveals that there is no significant difference between the promotion focused and preventive focused individuals in perceiving the course. However, the correlation analysis shows a moderate positive association with low preventive score (new to the course) and the corresponding subject score. That is, an individual with low preventive score who is new to the course, may be cautious that he/she should not be rejected while appearing for the interview and to become an employable graduate, is motivated to learn the course. Also, there is a low positive correlation between low promotion score (familiar to the course) and the corresponding subject score. That is, an individual with low promotion score who is already familiar with the course, may be motivated to gain the satisfaction of becoming an employable graduate and getting job. In future, a greater number of colleges and a greater number of factors may be analysed to know the outcome of the course.

LIMITATIONS
Only one Engineering College students were taken for the survey. The gender, studied in a school located at Rural/Urban, etc., of the participants have not been considered.

DATA AVAILABILITY STATEMENT
The authors will freely share the unfiltered raw data that supports the results of this article.

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Table 1: Correlation coefficients between the individual's promotion score, preventive score and the subject score

	Promotion Score	Preventive Score	Subject Score
Promotion Score	1		
Preventive Score	0.164497	1	
Subject Score	0.242882	-0.06492	1

Table 2: Correlation coefficients between Low Promotion Scores and Subject Scores (New to the course)

	LPSs	Subs
LPSs	1	
Subs	-0.14787	1

Table 3: Correlation coefficients between High Promotion Scores and Subject Scores (New to the course)

	HPSs	Subs
HPSs	1	
Subs	-0.25469	1

Table 4: Correlation coefficients between Low Promotion Scores and Subject Scores (Not new to the course)

	LPSs	Subs
LPSs	1	
Subs	0.183062	1

Table 5: Correlation coefficients between High Promotion Scores and Subject Scores (Not new to the course)

	HPSs	Subs
HPSs	1	
Subs	-0.00517	1

Table 6: Correlation coefficients between Low Preventive Scores and Subject Scores (New to the course)

	LPreSs	Subs
LPreSs	1	
Subs	0.419249	1

Table 7: Correlation coefficients between Low Preventive Scores and Subject Scores (Not new to the course)

	LPreSs	Subs
LPreSs	1	
Subs	-0.12131	1

Table 8: Correlation coefficients between High Preventive Scores and Subject Scores (Not new to the course)

	HPreSs	Subs
HPreSs	1	
Subs	1	1

Table 9: Summary High Promotion Scores and Low Promotion Scores

Groups	Count	Sum	Average	Variance
HPS	6	205	34.16667	64.96667
LPS	8	285	35.625	62.55357

Table 10: ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	7.291667	1	7.291667	0.114723	0.740683	4.747225
Within Groups	762.7083	12	63.55903			
Total	770	13				

Table 11: Summary High Preventive Scores and Low Preventive Scores

Groups	Count	Sum	Average	Variance
Column 1	2	58	29	8
Column 2	5	161	32.2	65.2

Table 12 ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	14.62857	1	14.62857	0.272109	0.624195	6.607891
Within Groups	268.8	5	53.76			
Total	283.4286	6				

RESEARCH ARTICLE

Diabetic Retinopathy Lesions Identification and Classification using 121-Layers Convolutional Neural Network with Discriminative Features.

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ABSTRACT

Diabetic Retinopathy (DR) is a complication that occurs due to diabetes and leads to abnormalities on the retina. The person may loss vision if they are not treated in the early stage. Various research article has contributed detection tools based on the machine learning architecture for ophthalmologists to diagnose the disease and categorizes the disease stages in the fundus images. A novel Discriminative Convolution Neural Network 121 layer architecture has been architected to diagnose the DR. In the first phase of the proposed architecture, the retinal images are enhanced using different techniques, from the pre-processed images, the features are extracted using Orient Fast and Rotated Brief technique. Feature of the retina covers Blood Vessels, Fovea, Optic distance, Blot Haemorrhages, LBP energy Exudate number and its area, Macular Edema, Micro aneurysms, and LBP Entropy. On obtaining those features, the inferential model causes false results on processing it. Hence, feature reduction has to be influenced in this work through Linear Discriminant Analysis that excludes the extraneous features before the segmentation process. Further, the selected features are segmented as normal and abnormal features employing the Fractional order Particle swarm optimization model. Finally, the segmented abnormal features are fed into the Discriminative Convolution Neural Network-121 architecture that detects retinal infection development and the stages of the disease. The outcome of the proposed system has been evaluated by using MESSIDOR and Image-Ret Database. The proposed architecture produces good results compared with the existing method.

Keywords: Discriminative Convolution Neural Network, Diabetic Retinopathy, Oriented Fast and Rotated Brief, Linear Discriminant Analysis, Particle Swarm Optimization

INTRODUCTION

Diabetic Retinopathy (DR) occurs due to the variation in the blood vessels. The size of the blood vessels may be changed due to DR in terms of length, width and diameter [1]. DR has created new, small and abnormal blood vessels that may cause bleeding in the retina called neovascularisation, if it goes unnoticed in the early stage, the person may lose vision. Health experts refer to the DR as two types, Proliferative Diabetic Retinopathy (PDR) and Non-Proliferative Diabetic Retinopathy (NPDR). PDR is the final stage of DR. Small fragile vessels are grown in the retina. Sometimes the PDR is diagnosed by the presence of blood in the vitreous cavity. The early stage DR is known NPDR; our proposed system aims to detect the lesions in the initial phase and to avoid vision loss. The final stage of NPDR is diagnosed by the bleeding in the retinal area and the presence of a new tiny blood vessel branch. The aforementioned abnormalities are identified during pathology and anatomy study of the retinal images, it will grade the existence of lesions -like Microaneurysms, haemorrhages and exudates[2]. Figure 1 represents the different symptoms of DR. These complications may occur at any stage of DR. According to the World Health Organisation (WHO), health reports and journals, the number of people affected the diabetes increased four times within 35 years of time and in India number of persons with diabetes may be 120 million by 2023. In manual observation of the retina, the tiny vessels may go unnoticed also it is a time-consuming process. Hence, health experts are in need of a computer-aided diagnosis system to diagnose the DR in order to provide the correct treatment in the early stage. In this article, a novel Discriminative Convolution Neural Network 121 layer has been proposed with different steps, which includes (i) pre-processing, (ii) Feature Extraction, (iii) Feature reduction, (iv) Segmentation and (v) Classification. The prediction of the lesions and severity of the DR is derived from the prognostic factor, which is based on DR lesions and the ground truth data of the retina. The second segment describes the study of existing learning methods for diabetic retinopathy classification, third section describes the current architecture, fourth section presents the outcomes of the proposed method using multiple different datasets, and summarises the overall proposed system in the final section.

Related Works
The following section discuss about the existing learning architectures to predict the DR as well as the classification of color fundus images.

Machine Learning
Many studies have been carried out to diagnose and classify DR using Machine Learning techniques. Ab Kader *et. al*, presented a paper to find the optimal performance in DR classification. In this study, 3 classes such as patients who do not have DR, PDR and NPDR are considered [4]. Du J *et al*, proposed a model, which differentiate the DR lesions effectively using descriptors. Shailesh Kumar *et al*, contributed a model for classification using Radial basis function [6]. Yadav *et al*, extracted the features from the segmented region using statistical technique and the features were fed into the different classifiers, which classify the retinal lesions [7]. Zhang *et al*, characterized the new candidates and classified the lesion [8]. Kaur presented a technique that segment the DR lesions using dynamic thresholding irrespective of bright and weak boundaries [9].

Deep Learning
Deep Learning (DL) methods require fewer human interventions since these methods learn the appropriate features directly from the data, and no handcrafted features are generated. Many researchers have developed many DL algorithms for diagnosing and classifying retinal lesions in medical images DL is learn from a large dataset. Many researchers for better classification and diagnosis of DR on disease pathology and anatomy have presented the deep learning models. These architectures are able to identify and learn the retinal features and severity of the diseases by grading the lesions. GoogLeNet and AlexaNet are suitable CNN architectures for exploring the disease type, also locating the optic disc without reducing the three-dimensional arrangement of the information [10].

Wang *et al*, proposed a deep model namely DCNN that automatically learns the deep facts of retinal lesions and the Random Forest method is employed to identify the DR lesions [11]. Yaqub *et al*, have presented DL-based image reconstruction for different retinal images modalities [11]. Kalyani *et al*. presented a Capsule network to detect and classify DR [13]. Heydon *et al*, proposed Artificial Intelligence and DL methods for clinically equivalent and speedy diagnosis of DR, especially for the large set of databases [14]. Ting *et al*, have diagnosed the DR using the DL system, that system was trained for different ophthalmological diseases such as DR and glaucoma [15]. Oh *et al*, presented ultra-wide-field fundus photography techniques [16]. Gaurav *et al*, presented different CNN learning models for DR detection [17]. Diabetic Retinopathy disease classification based on the lesion appearance and its characteristics is carried out using deep learning architecture termed Dense CNN. It has been exploited, as it is more advantageous in discriminating the lesion's features efficiently and accurately in order to prevent the disease from multiplying and spreading.

From the above study of deep learning and machine learning models, these models first pre-process the fundus images then features are extracted from the enhanced image. Further, the features are segmented and fed into different classifiers. The effective utilization of relevant features is not concentrated in the existing models. Hence, we need an automatic diagnosis system to identify the relevant features for diagnosing the DR lesions. There is a need to diagnose the DR lesions at an initial stage, hence the experts can provide the treatment at the right time and avoid vision loss, Also accuracy of the DR detection system to be improved. The proposed Deep learning architecture follows the feature reduction process and utilizes the relevant features for DR classification.

Proposed Model
For detecting diabetic retinopathy disease, a new deep learning architecture called the Discriminative Convolution Neural Network framework has been developed. Microaneurysms, haemorrhages, hard exudates, and soft exudates are just a few of the imaging elements that can grade the different stages of the lesion and aid in diagnosis. These lesions are predicted using various processes as illustrated in Figure 2.

Image Pre-processing
In this stage, the color fundus images are enhanced using different pre-processing techniques. Image Denoising – The non-linear filter called the Median filter can denoise the image and sortspixels in the neighbourhood according to the gray level. The result of Median filter is illustrated in Figure 3[18].

Contrast Enhancement
The Contrast Limited Adaptive Histogram Equalization (CLAHE) method can work on the minor section of the images and the performance can be computed through image histograms. Figure 4 represents the CLAHE result.

Feature Extraction
The output of the CLAHE method is the input of the Feature extraction process, features are extracted from the image using the Oriented FAST and Rotated BRIEF (ORB) method. It is used for texture analysis of the fundus images. ORB is a combination of Feature Accelerated Segment Test (FAST) and Binary Robust Independent Elementary Feature (BRIEF). The FAST method detects the edges and the BRIEF method provides the descriptor. The FAST method does not compute the location of the fundus image, this limitation is overcome by the ORB method [20]. Figure 5 represents the different features of retinal fundus images.

Feature Reduction: Linear Discriminant Analysis
Extracted features through the ORB technique are given to the Linear Discriminant Analysis (LDA) process for feature reduction. This process extracts only the important discriminative features that are relevant for DR detection. In this proposed work, linear discriminant analysis is used to reduce the number of retrieved features for diabetic retinopathy using the ORB technique. It represents a vector made up of variation structures, which is an aggregation of detected variables with the best weights. Additionally, it shows how the Fisher criteria function's picture variation varies in terms of variance. The most variation is shown in each aspect of the photograph. Since patterns in high-

dimensional data can be difficult to identify, LDA does not reduce the significant information instead the number of dimensions are reduced. The feature vectors of the blood vessel patterns make up the final component [20].Feature reduction process result shown in Figure 6

Fractional order Particle Swarm Optimisation Segmentation
The normal and abnormal features are segmented by using the Particle Swarm Optimisation (PSO) technique from the selected discriminative features. The PSO fitness function utilizes function particle and velocity study using the obtained discriminative features. Fractional order PSO fitness function is applied to segment the retinal lesions effectively for the investigation.

Lesion Particle Analysis
Particle is a parameter used to differentiate between normal and pathological macular edema. Macular edema makes up a Particle of the PSO Model. When there is a slight variation between the image area of the edema section and the image of the edema reflected from the major axis, a particle has been obtained. The four axes—vertical, horizontal, and two diagonal—are suitable for indicating the rate of symmetry [21]. Figure 7 displays the fundus image's asymmetry analysis. Border Irregularity is the important parameter that computes the edge type of edema on a range of sizes.The radial distance of the determined section will be computed with a large variance for the edema with irregular boundaries. M depicts the Centroids' g and the average distance d between boundary points.

$$R_d = \frac{1}{m} \sum_{k=0}^{n} p\varepsilon C(d(p,g) - m))$$

Colour Texture Analysis is used as a parameter for identifying color and textural variations in the edema area.

Correlation
It is calculated using the pair wise associations of the features that were taken from the variance of the color texture's edema region. It is calculated as follows,

$$Ci = \frac{1}{n} \sum_{x\varepsilon C}^{1} (x - m\,i)(x - mj)^T$$

Contrast is calculated as follows

$$\boldsymbol{Cr} = \frac{1}{n} \sum (mi - mj)(mi - mj)^T$$

To produce the segmentation results as normal or abnormal features, the value of all particles is aggregated according to the fitness function on maximizing pair wise correlation.

Discriminative Convolution Neural Network
In this section, a 121-layered Discriminative Convolution Neural Network is used to segregate abnormal characteristics associated with diabetic retinopathy. Through prognostic factors of pictorial and functional results in several retinal infections in different stages based on detection of DR lesions. Discriminative Convolution Neural Network determines the progression of the disease and the severity of the disease. With the help of the LDA and PSO Approaches, GoogLeNet architecture will provide feature maps with the minimum possible resolution and contextual information about each feature.   The DCNN-121 network design includes five convolutional layers with 5 x 5 x 5 element kernels. To identify the various types of diabetic retinopathy conditions, it learns the edema-targeted aspects.

Max pooling Layer
A 2x 2x2 max-pooling layer is used for observing the underlying connections between the ensembles of features with desired properties that have been rendered as parameters with spatial invariance calculation of the disease characteristics. The severity of diabetic retinal edema is identified with the existence of different DR lesions. It improves the model's ability to generalize even further.
The mapping of features is provided $F \varepsilon R^{C*H*W}$

Network Layer

Through their inherent processes, the network layers obtain the global spatial imaging features of attributes as well as the distinguishing characteristics between the various phases of diabetic retinopathy on the ReLu algorithm function of activation function. The network layers manage low-level to abstract aspects hierarchically. [22].

Activation Function

The activation function for the rectified linear units (ReLU) in the architecture causes nonlinearity in the model. The batch normalization process improves the system generalization. The Figure 8 illustrates the CNN GoogLeNet Architecture to recognize disease classes,

Data Prediction

Coloured saliency map technique is used for data prediction. The color depicts the system's stage representation location, which is largely discriminative. The Saliency Map displays relatively distinct significant abnormal regions (such as the prognostic region's peak point). The proposed DCNN-121 model highlights the abnormalities in the retina for easy identification of DR. Instead of using the random parameters, the model uses the discriminative features to identify the abnormalities in the retina. We would anticipate the system to highlight the potential areas of diabetic retinopathy in diseased instances.

EXPERIMENTAL RESULTS

MAT LAB (version 2019b) simulates the model that uses the MESSIDOR and ImageRet fundus image dataset to assess the model. It is quite difficult to train and validate the system because of the processing of the image. The proposed model validated 20% of the data and 80 % of data are used to train the appropriate expert lesion characterization. In the training process, the dataset is divided into 60% for training and 20 % for validation. To stop data leakage and improve the training model's accuracy, 5-fold cross-validation is used in this instance. The proposed model uses the training parameters such as MRP Volume as 3*3*100 pixels, Learning rate as 10^{-4},Cross entropy loss function, Batch size is 25 and finally 50 Max epoch.

Median Filter

Peak Signal to Noise Ratio (PSNR) indicates the pre-processed image's quality after the median filter has been applied. Using mean square error, the PSNR value is obtained [23]. Structured Similarity Index Measure (SSIM)calculates the structure similarity between the original and contrast improved image [24]. Table 1illustrates the outcome of the PSNR and SSIM values for median filter outcomes.

CLAHE Process

The projected contrast enhancement process results in the figure demonstrate how well this technique works to save important image details while sharpening fundus features. Additionally, it improves the accuracy of the classification steps based on the DCNN-121. Figure 9 illustrates the CLAHE output [25].

Feature Detectors

Execution time and error rate have been used to calculate the rate at which the feature descriptors perform in terms of identifying the critical spots. The proposed system effectiveness is estimated based on the variance in pixel values for the descriptor features is determined by the error rate.

$$Error\ Rate = (FP + FN)/Total$$

Table 2 represents the result of the feature descriptors represented error rate.

Classification

At each fold of validation, the proposed model utilized texture level information to estimate the classification performance. Correlation is a performance indicator used to calculate classification performance. The model

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provides 0.90 correlation value. The similarity of an image instance inside the class was evaluated using the correlation coefficient. The following equation represents the correlation coefficient.

$$corr\left(\frac{A}{B}\right) = \frac{\sum_{i=1}^{M} \sum_{j=1}^{N} (A_{i,j} - \bar{A})(B_{i,j} - \bar{B})}{\sqrt{\sum_{i=1}^{M} \sum_{j=1}^{N} (A_{i,j} - \bar{A})^2 \sum_{i=1}^{M} \sum_{j=1}^{N} (B_{i,j} - \bar{B})^2}}$$

The results were cross-validated using ground truth images for lesions. The performance of the proposed model has been measured with Dice Similarity Coefficient, sensitivity, specificity, precision, F1 score, Recall and accuracy, represented in Table 3. Performance analysis of the proposed model on two dataset against the different lesion produces with 99.83% and 99.28% Accuracy. The average performance metrics values of the proposed model for two datasets are represented in TABLE 4. Based on the classes generated for the classification of DR lesions, the performance outcomes of the accuracy of the current architecture and the existing model are estimated. The proposed model is compared with the existing Dense CNN models and the results are illustrated in Table 5 and Figure 10. Discriminative CNN 121 layered architecture learning methods perform better than the existing disease analysis method. It proves that high true positive values represent the lesion appearance related to diabetic retinopathy. The proposed model provides improved performance with reduced features using linear discriminant analysis. The performance produces the nearest results on validating with ground truth data. Classification of deep features that reduce over fitting.

CONCLUSION

This work utilizes GoogLeNet Architecture to design and implement a discriminative Convolution Neural Network 121 layer towards screening of DR with identification, classification and forecasting of abnormality grading in retinal fundus pictures of the retina on MESSIDOR Dataset and Image-Ret Dataset. The DCNN-121 architecture is employed to design and implement many processing steps. This includes the CLAHE technique to enhance picture contrast, the ORB technique for extracting features, the LDA technique for reducing features, and the PSO fitness method for segmenting the normal and abnormal features. In the final analysis, the DCNN-121 architecture is used to assess diabetic retinopathy disease together with patient prognosis. It has been demonstrated through experimental research that the proposed architecture outperforms the existing deep learning model in comparing with different parameters such as accuracy, Sensitivity, Specificity and Dice Coefficient.

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Table 1: Median Filter Results

Parameter	Train Image	Test Image
PSNR	0.97	0.95
SSIM	0.98	0.95

Table 2: Feature Descriptors

Feature Descriptors	ORB	SIFT
Image 1	0.08	0.18
Image 2	0.09	0.21

Table 3: performance metrices for the proposed Discriminative CNN 121 layered architecture

DATASET	Sensitivity	Specificity	Precision	F1 Score	Accuracy	DICE Co-efficient	Recall
Messidor	0.9991	0.9600	0.9991	0.9901	0.9983	0.9730	0.9475
ImageRet	0.9945	0.8889	0.9945	0.9945	0.9928	0.9966	0.9946

Table 4: Average Performance Metric Values Of The Proposed Discriminative Cnn121 Model

MESSIDOR & IMAGERET	Sensitivity	Specificity	Precision	F1 Score	Accuracy	DICE Co-efficient	Recall
	0.9928	0.924	0.9923	0.9923	0.9956	0.9848	0.9711

Table 5: Proposed DCNN-121 and Existing Dense CNN

MODEL	Dataset	Sensitivity	specificity	Accuracy
Proposed Discriminative CNN 121 layered	**Messidor**	**99.91**	**96.00**	**99.83**
Existing - Dense CNN		**97.5**	**85.62**	**98.90**
Proposed Discriminative CNN 121 layered	**Image Ret-DIARETDB 0**	**99.45**	**88.89**	**99.28**
Existing - Dense CNN		**97.60**	**86.83**	**98.89**
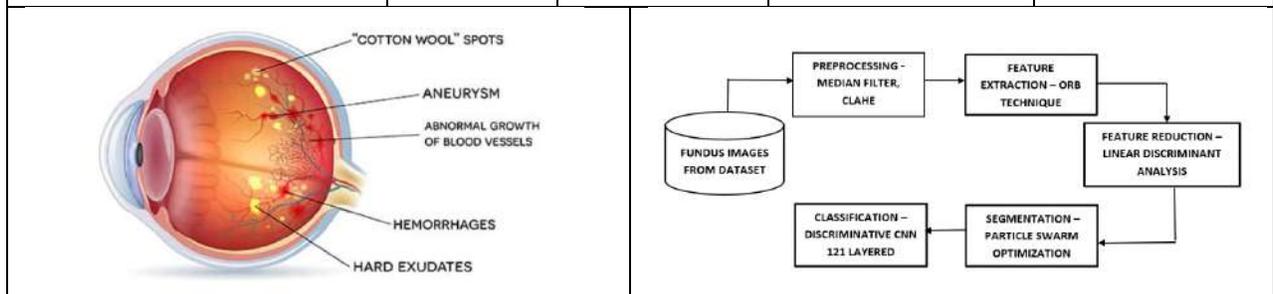
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Figure 1: Retina with DR Symptoms [3]	**Figure 2:Proposed DCNN 121 – Block Diagram**
Figure 3: Output of the Median filtering	**Figure 4: Output of CLAHE Method**
Figure 5 : Different Features of Retina	**Figure 6: Feature Reduction using LDA**
Figure 7: Lesion Particle analysis of the fundus image	**Figure 8: GoogLeNet Architecture for Disease Classification**

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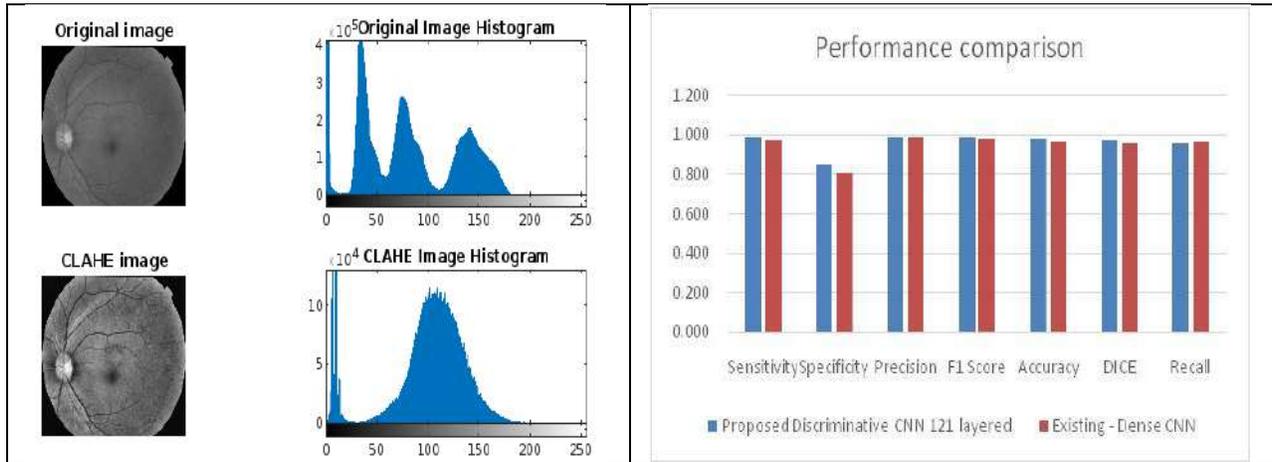
| **Figure 9: Original and CLAHE Images and Histogram** | **Figure 10: Performance Comparison** |

RESEARCH ARTICLE

A Comprehensive Overview of Adrenal Insufficiency : Aetiology, Pathophysiology, Clinical Presentation, Diagnostic Approaches and Treatment Strategies

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ABSTRACT

Adrenal insufficiency (AI) is an endocrine disorder manifested by adrenal hypo function, which results in insufficient glucocorticoids and mineral ocorticoids, particularly cortisol. It is a frequent ailment with a variety of causes that can be classified as primary, secondary, and tertiary. 21 alpha-hydroxylase deficiency and 17-hydroxylase deficiency, congenital isolated ACTH deficiency and congenital ACTH deficiency, and an excess of adrenal steroid hormones as well as adrenal medulla dysfunction are the main causes of primary, secondary, and tertiary adrenal insufficiency, respectively. AI symptoms overlap with those of other somatic diseases, which are often missed or misunderstood. The adrenal corticosteroid hormones, their regulatory peptide hormones, and stimulation tests are used to make the diagnosis. The goal of treatment is to use glucocorticoid and mineralocorticoid hormone replacement to personalise the patient's daily demands. In this review, we have discussed the aetiology, pathophysiology, diagnosis, and management of AI.

Keywords: Adrenal insufficiency; Cortisol; 21 alpha-hydroxylase deficiency; 17- hydroxylase deficiency; Glucocorticoid; and Mineralocorticoid

INTRODUCTION

Adrenal insufficiency (AI) is an endocrine disorder manifested by adrenal hypo function, which results in insufficient glucocorticoids and mineral ocorticoids, particularly cortisol [1, 2]. The symptoms are frequently nonspecific and subtle and include fatigue, unexplained weight loss, anorexia and nausea, postural dizziness, and hyper pigmentation [3, 4]. Electrolyte imbalances (hyponatremia and hyperkalaemia) are also possible [5]. It can cause significant morbidity and mortality in both children and adults [6–11]. It is classified as primary, secondary, or tertiary based on its cause. The autoimmune destruction of the adrenal cortex is the cause of primary adrenal insufficiency (PAI), also known as autoimmune adrenalitis or Addison's disease. PAI is rare, with only 10–20 cases for every 100,000 people. The most common inherited type of PAI is congenital adrenal hyperplasia (CAH). CAH is a group of auto somal recessive disorders caused by an enzyme deficiency that results in defects in the biosynthesis of steroid precursors. The most frequently detected deficiency is 21-hydroxylase (21-OHase) [2, 12, 13]. In the first instance, hyponatremia, hypoglycaemia, and hyperkalaemia in the first few weeks of life indicate adreno-cortical insufficiency caused by CAH [13]. Secondary adrenal insufficiency (SAI) is caused by pituitary gland function defects such as pituitary adenomas or their therapies, resulting in a decrease in adreno corticotrophin hormone levels (ACTH) [2, 14]. SAI has an incidence of up to 42 cases per 100,000 people. Cancer immunotherapy and long-term opioid use have been associated with an increased risk of SAI. Tertiary adrenal insufficiency (TAI) is caused by a decrease in the level of corticotrophin-releasing hormone (CRH) released from the hypothalamus, and exogenous steroid use is considered a common cause [2, 14]. Depending on the route of gluco corticoid administration, TAI risk is reported to be 4.2% for intranasal delivery, 20% for inhaled glucocorticoid therapy, 49% for oral preparations, and 52% for intra-articular administration [1]. In this overview, we explained the hypothalamic-pituitary-adrenal (HPA) axis, aetiology, patho physiology, clinical presentation, diagnosis, and management of adrenal insufficiency.

Hypothalamic-Pituitary-Adrenal (HPA) Axis
External physiological stimuli such as changes in the light/dark cycle or the presence of real or perceived stress activate the parvocellular neurons (PVN), which are a densely packed set of neurons located in the hypothalamus [15,16]. PVN secretes corticotropin-releasing hormone (CRH), arginine, and vasopressin to regulate adreno corticotropin (ACTH) secretion (Figure 1). It also regulates hunger and autonomic functions, inhibits nociception, and promotes analgesia [17]. The secreted hormones in the hypothalamus will be carried through the median eminence capillaries and magno cellular neurons, a part of the portal system, into the pituitary gland. The median eminence capillaries carry CRH from the PVN into the anterior pituitary to produce ACTH in corticotroph cells. where magno cellular neurons carry arginine and vasopressin into the posterior pituitary to produce vasopressin and oxytocin [18, 19]. This travels through the bloodstream to the adrenal cortex's zona fasciculata, where it activates the production and subsequent release of gluco corticoids [20].

Aetiology of Adrenal insufficiency
Primary adrenal insufficiency (PAI) is a rare but potentially fatal illness caused by a number of factors. The most common aetiologies are haemorrhage, infiltrative disorders or metastases, infection, and drug effects. However, congenital adrenal hyperplasia is due to 21 alpha-hydroxylase deficiency, 11 beta-hydroxylase deficiency, 17 alpha-hydroxylase deficiency, P450 oxidoreductase deficiency, steroidogenic acute regulatory protein deficiency, cholesterol side-chain cleavage deficiency, and 3 beta-hydroxysteroid dehydrogenase deficiency [21–23]. SAI can be caused by congenital isolated ACTH deficiency, congenital ACTH deficiency in combination with other pituitary deficiencies, anterior pituitary function deficit, variable immune deficiency syndrome, or acquired ACTH deficiency. TAI can be caused by an excess of adrenal steroid hormones as well as adrenal medulla dysfunction. Excess adrenal steroid hormones are seen in cases of Cushing syndrome, adrenal androgen excess, premature adrenarche, idiopathic excess, and mineralocorticoid excess. TAI with disorders of the adrenal medulla is present in adrenal medulla hormone deficiencies, primary tumours in the adrenal medulla, tumours (http://www.icped.org). The recent study focused on a genetic defect as a possible cause, such as nicotinamide nucleotide transhydrogenase (NNT),

minichromosome maintenance 4 (MCM4), thioredoxin reductase (TXNR2), and glucocorticoid resistance (GR, NR3C1) [24].

Pathophysiology

The adrenal cortex is regulated by two separate regulatory circuits: the HPA axis and the renin-angiotensin-aldosterone system (RAAS). Any external or internal factors that affect the regulatory circuits will compromise the adreno cortical zones of the adrenal cortex. which results in the depletion of glucocorticoids and mineralocorticoids. Depletion of glucocorticoids and mineralocorticoids also results from a lack of ACTH activation, as stimulation of ACTH will secrete adrenocortical hormones from the zona fasciculata and zona reticularis [1]. In the steroid biosynthesis pathways, the 17-hydroxylase enzyme is required for the production of cortisol and sex steroids. After the formation of pregnenolone and progesterone from cholesterol, the 17-hydroxylase enzyme is responsible for converting them into 17-hydroxypregnenolone and 17-hydroxyprogesterone, respectively. 17-hydroxypregnenolone and 17-hydroxyprogesterone are the precursors to cortisol, estrone, and estradiol. A deficiency in 17-hydroxylase by a genetic mutation in the gene CYP17A1 also causes lower glucocorticoid and androgen production [25].

Clinical presentation

The clinical manifestation of adrenal insufficiency varies depending on the hormone deficiency, i.e., glucocorticoid deficiency and mineralocorticoid deficiency [2, 3, 5, 6, 26].

Gluco corticoid deficiency

The most common signs and symptoms of glucocorticoid deficiency are fatigue, weakness, anorexia, weight loss, nausea, vomiting, abdominal pain, arthralgia, myalgia, salt craving, dizziness, fever, skin pigmentation, hypotension, hypo glycaemia, and dehydration.

Mineralo corticoid deficiency

The most common signs and symptoms of mineralocorticoid deficiency are anorexia, weight loss, nausea, vomiting, abdominal pain, arthralgia, myalgia, salt craving, dizziness, skin pigmentation, hypotension, and dehydration.

Diagnosis of adrenal insufficiency

Adrenal insufficiency is under diagnosed because of the symptoms that overlap with other somatic diseases. Two-thirds of patients presenting with signs and symptoms of adrenal failure had multiple hospital visits before receiving an accurate diagnosis. Tests for blood cortisol, ACTH stimulation, insulin tolerance, CRH stimulation, and blood tests for autoimmune Addison's disease are used to differentiate the types of adrenal insufficiency. Computed tomography (CT) scans and magnetic resonance imaging (MRI) can be used to detect changes in the pituitary and adrenal glands. Along with these are routine blood tests for infections and serum electrolyte dis balance [27–29].

Management of adrenal insufficiency

Management must be targeted based on the cause of adrenal insufficiency. It is necessary to conduct a thorough investigation to determine the types and causes of adrenal insufficiency. Factors associated with developing adrenal disease *(haemorrhage, infiltrative disorders or metastases, infection, and drug effects)* should be identified and eliminated, as these will correct the condition on their own.

Glucocorticoid (GC) replacement therapy

Usually, oral hydrocortisone (15–25 mg twice or three times daily) is used as the primary treatment regimen for some time. The dosage is customised depending on the individual patient's requirements and the severity of their condition. Morning administration of half to two-thirds of the daily dose is recommended. Alternatives such as prednisone/prednisolone, cortisone acetate, and dexamethasone can also be used [30, 31]. Hydrocortisone is usually preferred above other alternatives because it closely mirrors the body's naturalcortisol production and has both glucocorticoid and mineralocorticoid properties [31, 32]. To avoid the potentially fatal condition known as an adrenal

crisis, stress dosage is necessary in situations like illness, injury, surgery, severe trauma, emotional stress, or other conditions that greatly raise the body's demand for cortisol. The precise stress dose regimen may vary depending on the individual, the strength of their initial medicine, the kind and length of the stressor, and other factors. Patients are advised to take their regular dose of glucocorticoids in double, triple, or more frequent doses throughout the day [21, 33, 34]. Hormone levels and clinical symptoms must be periodically observed to assess the efficacy of glucocorticoid replacement therapy and to avoid using excessive doses that could have undesirable side effects. An excessive dose or use for an extended period of time may cause adverse effects such as weight gain, high blood pressure, osteoporosis, mood changes, and an increased vulnerability to infections [32]. The patients are advised to adopt specific food and lifestyle adjustments, stress reduction methods, and exercise regimens.

Mineral ocorticoid (MC) replacement therapy

The synthetic mineralocorticoids fludro cortisone and fludro cortisone can successfully replicate the effects of cortisol in the body since they contain mineralocorticoid properties that are identical to those of natural mineral ocorticoids with greater potency and a longer duration of action. The two natural MCs, 11-deoxycortisol and aldosterone, are ineffective in the treatment of AI [35]. The starting dose of FC is 50 to 200 mcg per day in a single dose and then titrated to 25 to 50 mcg per day [21, 33, 35, 36]. Fludrocortisone therapy requires adjustments for each patient to attain ideal blood pressure and electrolyte balance. To compensate for sodium loss brought on by an aldosterone deficit, patients should be encouraged to consume more salt in their diet [37]. AI patients require lifelong steroid therapy, and careful monitoring is required to avoid under- or over replacement. The patients should be assessed carefully by measuring BP, inquiring about salt carving, and identifying the presence of peripheral oedema [33].

Gene therapy and gene editing currently under the clinical development
Adeno-Associated Virus (AAV) Vectors for Gene Replacement

The use of adeno-associated virus (AAV) vectors in gene replacement therapy for adrenal insufficiency appears promising. To re-establish regular hormone production, functional genes are delivered by AAV vectors into the adrenal glands. Research in preclinical animals suggests that AAV-based gene therapy may provide a safe and durable treatment option for genetic causes of adrenal insufficiency. Although this method of treatment is still in development, it offers hope to individuals who have specific genetic abnormalities that result in adrenal insufficiency [38].

CRISPR-Cas9 gene editing

With its ability to precisely fix mutations associated with adrenal diseases, CRISPR-Cas9 holds hope for individualised therapy. In animal trials and preclinical research, it has shown promise in treating a few inherited types of adrenal insufficiency. However, further research is required before adopting this strategy in therapy due to important issues about safety, delivery modalities, and unintentional genetic modifications [39].

Gene therapy for congenital adrenal hyperplasia (CAH)

This strategy focuses on the underlying aetiology of CAH and involves delivering functioning genes into the body. Although the research is still in the experimental phase, encouraging outcomes in preclinical tests and animal models give optimism for possible therapeutic uses. Prior to gene therapy becoming an effective treatment for people with CAH, challenges, including guaranteeing precise gene delivery and long-term safety, must be addressed.

Surgery

Surgery for adrenal insufficiency is usually only performed in cases where there are particular underlying diseases, like adrenal tumours or some forms of congenital adrenal hyperplasia (CAH). Adrenalectomy (removal of one or both adrenal glands) or corrective surgery for congenital adrenal hyperplasia are the two main surgical procedures [40, 41]. When previous therapies fail to control severe cases of adrenal insufficiency, bilateral adrenalectomy (removal of both adrenal glands) may be considered the last option. This unusual treatment seeks to control excessive cortisol [21].

CONCLUSION

Adrenal insufficiency is a disorder that affects the glucocorticoid and mineralocorticoid synthesis or supply. Obstacles in the steroidogenic pathway, such as CRH and ACTH hormones deregulation, may have an effect on the enzymes 21 alpha-hydroxylase and 17-hydroxylase leads to decrease or no production of endogenous corticosteroids. The treatment must be targeted based on the cause of adrenal insufficiency and many glucocorticoids and mineralocorticoids replacement therapy are used.

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REVIEW ARTICLE

Review on Modified Starch Act as Super Disintegrant for the Enhancement of Poorly Soluble Drugs

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ABSTRACT

Super disintegrants play a pivotal role in the realm of fast-dissolving tablets (FDTs), arrange swift and efficient disintegration. These remarkable agents exhibit extraordinary absorption capabilities and elevate swelling properties. When an active ingredient, residing within a solid unit dosage form, come into contact with saliva, it undergoes rapid dissolution, bypassing the requirement for water or mastication – a phenomenon accordingly describe as super disintegration. Utilize the prowess of super disintegrants activate tablet disintegration within mere seconds, fostering heightened bioavailability within a short timeframe and reduced concentration. Among these, modified starch emerges as a prominent contender, adroitly serving as a super disintegrant in the formulation of fast-dissolving tablets. A diverse array of starches, to come from sources such as beans, sweet potatoes, potatoes, cassava, sorghum, wheat, and rice, can be treat with chemical and physical modifications to yield their enhanced counterparts. The characteristic attributes of modified starches encompass swifter disintegration, superior flow ability, direct compressibility, and versatile gelation across varying temperature regimes. Within the realms of pharmaceutical and medical domains, the utility of modified starches burgeons, as they are increasingly embraced as essential excipients and pivotal constituents in drug synthesis. By embracing modified starches, the solubility of otherwise recalcitrant drugs is magnified, precipitating a reduction in disintegration time. The discernible disparity in compressibility between native and modified starches further underscores their transformative potential. Notably, modified starches shine as super disintegrants in the construction of fast-dissolving tablets (FDTs), oral

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disintegrate tablets, and rapid-release tablets, amplifying the solubility of challenging pharmaceutical agents.

Keywords: Fast dissolving tablets, Modified starches, Super disintegrants, Solubility enhancer

INTRODUCTION

Starch stands as the preeminent exemplar of a naturally abundant, biodegradable, cost-effective, and ubiquitously accessible polysaccharide and carbohydrate reservoir within the plant kingdom. This versatile biomolecule pervades various botanical components including leaves, flowers, fruits, seeds, assorted stem varieties, and roots. Comprising an exclusive assembly of glucose molecules, starch unites as a dynamic union of two distinct polymers – Amylose and Amylopectin. These intricate structures coordinate the plant's resource allocation and energy management, playing a pivotal role in the orchestration of metabolic processes essential to the plant's survival and prosperity.[1]. Starch assumes a ubiquitous role as an essential excipient in the fabrication of solid dosage forms, functioning as a versatile filler, disintegrant, and binder. Through meticulous modification, starches undergo transformative alterations to their inherent physical and chemical attributes, a metamorphosis that finds its application as potent disintegrants and superdisintegrants within solid dose formulations. The realm of solid oral dosage forms has witnessed the extensive incorporation of oral disintegrating tablets over multiple decades, embodying a dynamic evolution in pharmaceutical design and delivery. This enduring practice has contributed to clarify patient experiences and therapeutic outcomes [2]. Within the realm of disintegrants, a panorama of options unfolds, encompassing both natural and synthetic sources. Natural polymers like starches and gellan gum perform admirably in this capacity, facilitating efficient disintegration. In parallel, a collection of synthetic polymers, including polyvinylpyrrolidone, modified starches, cellulose derivatives, primogel, and cross povidone, stand as exemplars of ingenuity, propelling pharmaceutical innovation forward. This diverse spectrum of disintegrants empowers pharmaceutical formulators with a rich toolkit to tailor drug delivery systems for optimal efficacy and patient compliance.[2]. Superdisintegrants represent a specialized subset within the realm of disintegrants, carefully engineered to enhance the process of disintegration. These extraordinary agents possess excellent absorbent properties, fostering remarkable swelling attributes. Among the notable champions of super disintegration, Crospovidone (cross-linked povidone), Croscarmellose sodium (cross-linked cellulose), and Sodium starch glycolate stand as exemplars, each contributing to the art and field of rapid tablet breakdown [3]. Superdisintegrants have emerged as active components in the realm of fast-dissolving dosage forms, facilitating expeditious dissolution. A comprehensive survey of literature reveals a diverse array of both synthetic and natural superdisintegrants already established within the market landscape. Among these, starch, a versatile polymer, has garnered significant attention due to its accessible attributes, biodegradability, and biocompatibility. This polymorphic achiever has express the attraction of several researchers who have ingeniously modified its properties to unlock new dimensions of utility utility.[4],[5],[6].Upon extraction or isolation from plants, starch assumes two distinct forms: its unaltered, native state or as a modified derivative. In its native guise, starch retains its pristine, botanical essence. However, when it undergoes modification, intentional physicochemical adjustments are enacted, imparting fresh attributes to fulfil specific requisites. This deliberate transformation aims to bestow novel characteristics, tailored to meet desired benchmarks. This approach of modification is necessitated by the inherent limitations of natural starch. The unmodified variant often falls short of compatibility with various industrial processes and applications, primarily due to its incapacity to dissolve within solvents and maintain its integrity under the rigors of harsh industrial environments. Consequently, the tracking of tailored, modified derivatives arises as an imperative response to bridge the gap between natural starch's limitations and the demands of modern industrial exigencies.[7]. Starches undergo strategic modifications to usher in transformative alterations to their fundamental physical and chemical attributes. These purposeful modifications pave the way for a range of desirable traits in the resulting modified starches, including heightened flow ability, accelerated disintegration times, enhanced direct compressibility, and the remarkable ability to gel in both cold and hot water environments.[2]. In recent times, the pharmaceutical and

medical sectors have witnessed a marked upsurge in the utilization of modified starches, both as pivotal excipients and integral components in drug manufacturing. These tailored starch variants exhibit a remarkable capacity to enhance the solubility of poorly soluble drugs while concurrently curtailing disintegration time, thereby coordinate a harmonious synergy between efficacy and efficiency. Distinguished by their heightened compressibility compared to their native counterparts, modified starches hold the key to uniform product quality, underpinned by their consistent and reliable properties. In the dynamic domain of fast dissolving tablets (FDTs) and oral disintegrate tablets, these modified starches assume the role of superdisintegrants, wielding their transformative influence to elevate the solubility of challenging pharmaceutical agents. The ensuing cascade of benefits includes increase patient compliance, prevent the need for water consumption and expediting the onset of therapeutic action. Furthermore, the realm of FDTs unfolds as a promising alternative dosage form, proving particularly invaluable for geriatric and paediatric populations, as well as individuals with mobility limitations, cognitive impairments, or aversions to swallowing. The versatility of modified starches extends beyond these roles, encompassing five distinct categories: fat replacer, fat mimetic, texture improver, and high nutritional value, each contributing to the diverse spectrum of applications in the food industry.[8]. The integration of modified starch within disintegrants serves as a pivotal catalyst for the fragmentation of tablets and capsules into smaller fragments, facilitating the subsequent release of drugs for efficient absorption. Notably, starches exhibit rapid water absorption capabilities, further enhancing their role in promoting effective tablet breakdown.

This multifaceted modified starch serves as a versatile cornerstone, seamlessly transitioning between roles as a binder, disintegrant, and diluent within tablet formulations, all the while augmenting cold-water swell ability. Its influence extends to enhancing flow properties and serving as an integral component of direct compression processes. Notably, its solubility in cold water adds to its adaptability and utility. Functioning as a transformative agent, this modified starch also finds application as a lubricant and diluent, culminating in an overall enhancement of product performance. The integration of modified starch brings about notable advancements, particularly in elevating the solubility of poorly soluble drugs. Furthermore, the inclusion of modified starch leads to a reduction in tablet disintegration time, optimizing drug delivery. Diverse in its characteristics, this modified starch exhibits a gamut of attributes including heightened digestibility, adeptness as an emulsifying agent and emulsion stabilizer, proficiency as an encapsulating agent, capacity for cold-water swell ability, presence of charged starch molecules, refinement of cooking properties, facilitation of film formation, and contribution as encapsulation wall materials. Ultimately, the incorporation of modified starch signifies a pivotal step towards optimizing product performance and refining drug delivery modalities.

Types of Modified Starch [9].
Cationic starch.
Etherified starch.
Esterified starch.
Resistant starch.
Pre-gelatinized starch.

Cationic Starch
Cationic starches find their primary application as wet-end starches. Their versatile nature enables a diverse array of applications, notably as effective flocculants in water treatment, as well as valuable additives within industries such as textiles, paper manufacturing, and cosmetics. These starches are highly sought after for these specific functions owing to their affordability, exceptional compatibility, biocompatibility, and remarkable rate of degradation.[10].

Etherified Starch
Starches undergo etherification processes to yield products exhibiting exceptional pH stability. Among these, hydroxyalkyl starch derivatives play a pivotal role in various commercial applications. Notably, Hydroxypropyl starch, a significant derivative, finds its principal market in the realm of food applications, adding value and versatility to culinary endeavours.

Esterified Starch

Esterified starch, a prominent variant of modified starch, finds significant applications in both the food and adhesive industries. This distinctive category of starch is commonly generated via esterification or Trans esterification processes, wherein hydroxyl groups are strategically substituted with larger functional entities derived from free fatty acids or their derivatives. This transformative alteration grants esterified starch its notable attributes and renders it a valuable asset in diverse industrial domains [11].

Resistant Starch

The modification of resistant starch (RS) holds the potential to exert control over calorie and glucose intake.

Pre-gelatinized Starch

Pre-gelatinized starch (PGS) is the result of subjecting starch to a meticulous cooking process that culminates in complete gelatinization, coupled with a simultaneous drying procedure. This hybrid transformation is achieved through versatile drying methods such as extrusion, spray drying, and drum drying.[10].

Superdisintegrant

Superdisintegrants surpass traditional disintegrants by significantly enhancing disintegration time, even when employed at minimal concentrations ranging from 1 to 10% of the total weight of the dose unit. This class of agents serves to elevate the overall effectiveness of solid dose forms, ushering in enhanced therapeutic outcomes.

Superdisintegrants Provide the Following Advantages

Less concentration is required.

Compatible with a wide range of drugs and excipients.

It has no effect on compressibility or flowability.

Superdisintegrants Have the Following Disadvantages

They are sensitive to moisture, which causes instability.[12].

Expensive.[13].

Ideal Properties of Superdisintegrants [13].,[14].,[15].

1. It should disintegrate quickly.

2. It should have an excellent moulding and flow property.

3. It must have a good particle size, hydration capacity, and compressibility index.

4. It should be insoluble in water.

5. It should generate compactable and less friable tablets.

6. Effective at very low concentrations and should have higher disintegration efficiency.

7. Nontoxic and should have a pleasant mouth feel.

8. It should not form compounds with the medications.

9. It must be compatible with the other excipients and have desirable tableting qualities.

Starch Modification Methods
Chemical Modification of Starch
Cross-linking

The most common modified version used in industry is cross linking. It involves replacing the hydrogen bonds contained between starch chains with stronger, permanent covalent bonds. The most often utilised cross-linked starches are distarch phosphate or adipate. Cross-linked starches outperform native starches in acid, heat, and shear stability [16],[17], [10],[18].

Stabilization

This method is used in conjunction with cross-linking. Stabilisation is used to improve shelf life by allowing it to withstand temperature variations.[19].

Conversion

This is the general term for a variety of starch chain cleavage methods. Typically consists of acid hydrolysis, enzyme hydrolysis, and oxidation [20],[21].

Acid Hydrolysis

The acid reacts with and depolymerizes the amorphous areas of the granules, causing the granules to rupture fast when the starch is heated above its gelatinization temperature. This results in a hot, lower viscosity cooked starch that forms a stronger gel after heating than the native parent starch [20],[21],[22]

Enzyme Hydrolysis

Starch modified by the amylase enzyme yields a derivative with good adhesive properties. The extent of enzyme hydrolysis determines the range of chain lengths produced, such as glucose, maltose, oligosaccharides, and polysaccharides. Amylases preferentially and randomly target the 1 4-linkages of starch to create maltodextrins [20]., [23].

Oxidation

This is made by reacting native starch with sodium hypochlorite or peroxide. Oxidised starch products are primarily employed as surface sizing agents or coating binder and are available in a variety of viscosity grades **[20].,[21].,[24].**

Physical Modification of Starch
Pregelatinization of Starch

It is the most basic starch modification, made by heating the slurry, roll drying, spray drying, or extrusion. It keeps starch intact while enhancing cold water thickening. This method is intended to improve the adhesiveness of starches. Pregelatinized starches have good flow, binding, and compressibility [20],[21],[18]5,[25].

Annealing

This is done by soaking the native starch in excess water at temperatures ranging from 40 to 60% w/w between gelatinization. Annealed starch is less prone to swelling [20].And the resulting improved crystalline structure does not rupture the starch granules.[26].,[21].

Preparation of Modified Starches
Cross-linking of Maize Starch

To make it reactive, 20 g of dried maize starch was treated with 30 ml of ethanol. The slurry was then filtered to recover the starch residue. A slurry of reactive starch was prepared in an alkaline medium with 0.5% NaOH and various amounts of sucrose and formaldehyde as crosslinking agents [2.5, 5,10, 20,and 40%].. The mixture was held at 40 °C for 30 minutes with constant stirring. The pH of the mixture was then adjusted to roughly 5.0 with 0.1 N HCl before being rinsed and dried to recover the cross-linked maize starch. After drying, the particle size of the maize starch was decreased by passing it through a 0.17-mm mesh. This method was repeated for both T [27].

Preparation of Starch Glutarate

Santosh kumar *et al* discussedinitially, 10g of glutaric acid and 10g of potato starch were dissolved in 25ml of distilled water. The pH of the solution was then adjusted to 3.5. This dispersion was conditioned for 16 hours. The dispersion was dried in an oven at 60° C after conditioning. To eliminate any unreacted glutaric acid, the material was washed with distilled water. The product was dried in an oven at 60°C. The obtained product was crushed and sieved (# 120). Starch glutarate is an effective superdisintegrant for tablets that dissolve fast [28].

Preparation of Starch – Urea – Borate

Santosh Kumar *et al* developedgelatinizing potato starch in the presence of borax and urea resulted in the formation of starch-urea-borate. To make a starch slurry, 50 g of potato starch was dispersed in 100 ml of water that had been purified. Separately, 10.0 g of borax and 15.0 g of urea were dissolved in 400 ml of purified water and the solution was heated to boiling. The starch slurry was added and stirred in while the water was boiling. For 10 minutes, mixing while heating was continued to gelatinize starch and generate starch-urea-borate polymer. The resulting mass was placed onto a stainless steel plate and dried at 80°C for 6 to 8 hours. The powdered polymer was passed through mesh no. 120 [29].

Anilkumar Vadaga *et al.,*

Preparation of Modified Starch Acid

Santosh Kumar *et al* prepared initially, 10 g of glutaric acid were dissolved in distilled water, and the pH was corrected to 3.5 using 10M sodium hydroxide before a final volume of 25 ml was produced. 25 g potato starch was added to the previously mentioned mixture and conditioned for 16 hours at room temperature before being baked at 600 c for 6 hours. The mass was washed to remove unreacted glutaric acid. The goods was washed and dried at 600c. The finished product was powdered and sieved (# 100) Modified starch is an effective superdisintegrant for tablets that dissolve fast. The drug release time from the produced tablets was 10 minutes and depended on the tablet composition, i.e., the concentration of modified starch, croscarmellose sodium, and crospovidone [30].

Preparation of Starch Glycolate

Hariomprakashrao *et al* discussed initially, 10 parts potash starch were slurred in 10 parts distilled water and 10 parts starch glycolate were dissolved in distilled water. Both are stirred constantly for 30 minutes. pH was adjusted to 3.5 using 10M NaOH and stirred for 16 hours at 25 °C. After 16 hours, it was filtered and rinsed with distilled water. For 2 hours, the product was baked at 60 °C. The final product was ground and sieved [31].

Preparation of Starch Phthalate

Santosh kumar *et al* developed initially, 3 parts phthalic anhydride were dissolved in 2 parts dimethyl sulphoxide (DMSO). The pH of the solution was then adjusted to 3.5 using 10M sodium hydroxide (NaOH), and it was ultimately made up to 50 ml. 5 parts potato starch were added and conditioned for 16 hours. After conditioning, the dispersion was held in an oven at 60 ° C for one hour. The product was then mixed with acetone for 15 minutes before being rinsed with isopropanol to eliminate any unwanted phthalic anhydride. Following washing, the resulting product (starch phthalate) was dried in an oven at 60 °C. The resulting product was crushed and sieved (# 120). Starch phthalate is an effective superdisintegrant for tablets that dissolve fast [32].

Preparation of Starch Valerate

Santosh kumarrada *et al* discussed in a beaker, potato starch was blended with distilled water, and valeric acid was added while stirring frequently to ensure that the potato slurry was thoroughly mixed. The pH should then be tested and adjusted to 3.5 by adding 10M sodium hydroxide solution and conditioning for 16 hours at 60°C. As a result, following conditioning, the unreacted valeric acid is drained, washed with distilled water, and dried in an oven at 60o C for approximately 2 hours. The dried solid material was then sieved with sieve #120. The resultant fine powder is then starch valerate [33].

Preparation of Starch Tartrate

Santosh kumar *et al* prepared initially, 10 parts tartaric acid were dissolved in 25 ml of distilled water. The pH of the dispersion was determined. If the pH was not 3.5, a 10 (M) sodium hydroxide solution was added to adjust it to 3.5. This dispersion was condition for 16 hours. It was dried in the oven at 60 °C for 16 hours. The material was washed with distilled water to remove the unreacted tartaric acid. The product was dried in a 60 °C oven. The final product was powdered and sieved (# 80).Starch tartrate is an effective superdisintegrant for tablets that dissolve fast [34].

Preparation of Starch Glutamate

Santosh kumar *et al* developed the starch slurry was made by dissolving starch in distilled water. Glutamic acid was dissolved in distilled water before being added to the pre-prepared starch slurry. The pH of the glutamic acid and starch slurry was adjusted to 3.5 with 10 mL sodium hydroxide. This slurry was conditioned for 16 hours after pH adjustment, and unreacted glutamic acid was removed by washing it with distilled water. The resulting solid mass was dried at 60 °C to create starch glutamate. Dried starch glutamate was passed through a #120 sieve and stored in a desiccator [35].

Anilkumar Vadaga *et al.,*

Preparation of Starch Malonate
Annu kumara *et al* prepared esterification was used to create starch malonate from potato starch and malonic acid as starting materials(6). In 25 parts distilled water, 10 parts malonic acid and 10 parts potato starch were dissolved. By adding 10 M NaOH solution to the solution, the pH was changed to 3.5. The final mixture was conditioned for 16 hours. Following conditioning, the finished product was dried in an oven at 60 °C. The mass was washed with distilled water to eliminate the untreated malonic acid. Again, the product was dried in an oven at 60 °C until it was completely dry. The obtained product was crushed and sieved using sieve no.120#.Starch malonate, a modified starch, is an effective superdisintegrant for tablets that dissolve fast [36].

Preparation of Starch Crotonate
Hariom Prakash rao *et al* discussed to begin, dissolve 10 g of crotonic acid in 10 mL of distilled water, then add 10 g of potato starch in 25 mL of distilled water. Both were continuously swirled for 30 minutes. Increase the pH to 3.5 with 0.1N NaOH and stir for 16 hours at 25 °C. To extract unreacted crotonic acid, it had been purified and rinsed with distilled water after 16 hours. The product was then kept in a 60oC oven. The goods obtained were ground and sieved [37].

Preparation of Starch Tartrate
Santosh Kumar et aldeveloped initially, dissolve 10g tartaric acid in 25ml distilled water. To achieve dispersion, potato starch was added. The pH of the solution was then adjusted to 3.5 by adding 10M sodium hydroxide. For 16 hours, the solution was conditioned. It was dried in the oven at 600c. The material was rinsed with distilled water after drying to eliminate the unreacted tartaric acid. The product was dried in an oven at 600c. The obtained product was ground up and sieved through sieve no. 80.Starch tartrate is an effective superdisintegrant for tablets that dissolve fast.[38].

Preparation of Starch Citrate
Santosh Kumar *et al*[39].prepared citrate was made by dissolving 10 g of citric acid in 25ml of distilled water. The pH of the citric acid solution was corrected to 3.5 by adding drop wise 10M sodium hydroxide, and the volume of this solution was increased to 50 ml by adding distilled water. Following that, 25 g of potato starch was added to the previously produced solution and left to cure at room temperature for 16 hours. After 16 hours, the mixture was dried for six hours at 60°C in a hot air oven. The unreacted citric acid was removed by washing the mixture with distilled water and then drying at 50°C, which resulted in complete moisture removal [40]., [21].

Preparation of Starch Hyaluronate
Anusha kusuma *et al* discussed10 g of potato starch was suspended in 15 mL of distilled water in a beaker. 10g of hyaluronic acid were weighed and added to the starch slurry; the pH of the slurry was then adjusted to 3.5 with 10 mL sodium hydroxide and left idle for the esterification reaction. The mixture was then treated with distilled water to eliminate any leftover hyaluronic acid before being dried at 60°C to generate a dry bulk. The dried starch hyaluronate was filtered with a #120 sieve to obtain uniform-sized particles before being stored in a desiccator.[41].

Applications of Modified starches in Pharmaceuticals and Medical Industries
In recent years, pharmaceutical companies all over the world have made extensive use of various types of modified starches in various stages of drug the production or development technologies. Excipients contribute significantly to the mechanical strength, stability, and tablet disintegration qualities of solid dose formulations [20].

CONCLUSION

Various approaches can be performed or used to improve the dissolution of poorly soluble drugs in an oral solid dosage form, ranging from incorporation in modified starches, which are widely used as superdisintegrants, in future trends in drug delivery systems, and in the production of oral disintegrating or fast dissolving tablets. Further

research is needed to demonstrate the application of functional and multi-functional excipients to improve the solubility or dissolution, and hence the bioavailability, of an extensive variety of poorly soluble drugs. Considering that up to 40% of current medicine products contain drugs with low aqueous solubility, and up to 90% of newly discovered therapeutic compounds in the development phase have poor aqueous solubility. In the future, identifying the best formulation and development of modified starches as an excipient in relation to new medications may result in successful drug delivery with considerable lower economic charges.

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RESEARCH ARTICLE

Current Regulatory Requirements to File OTC Drugs in Australia

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ABSTRACT

This in-depth article delves into the complex and ever-evolving landscape of regulatory requirements for Over-the-Counter (OTC) drugs in Australia. OTC medications are essential to health care since they are available to consumers without a prescription. It provides an in-depth analysis of the complex procedures and methods required for getting approvals for OTC pharmaceuticals, including critical elements such required documentation, stringent quality controls, and thorough safety evaluations. Additionally, it clarifies the complex responsibilities of producers, importers, and sponsors with regard to complying with Australia's regulatory framework while highlighting the crucial part that ongoing post-market surveillance plays in guaranteeing the long-term safety and effectiveness of OTC medications made available to Australian consumers.The Therapeutic Goods Administration (TGA) is the regulatory body in charge of policing over-the-counter medications in Australia. Through the whole clearance process, safety issues are given the utmost priorications,ity. Each OTC medicine is subject to a thorough risk and benefit analysis by the TGA, which takes into account the drug's intended usage,

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potential adverse effects, and the targeted customer base. under the direct supervision of a medical expert.Manufacturers, importers, and sponsors all play crucial responsibilities in ensuring that the legal framework is followed. They are accountable for continued post-market monitoring in addition to providing accurate and thorough paperwork.In conclusion, navigating Australia's OTC medicine regulations is a complex procedure that needs painstaking attention to detail, observance of quality controls, and a dedication to continual safety monitoring. This page promotes a better awareness of the stages and responsibilities involved in providing safe and effective pharmaceuticals to consumers in Australia, serving as a helpful resource for anyone working in the OTC drug sector.

Keywords: OTC medications, TGA, Safety, Documentation, Post market surveillance

INTRODUCTION

The pharmaceutical industry plays a vital role in ensuring the health and well-being of individuals worldwide. Over-the-counter (OTC) drugs, also known as non-prescription drugs, are an integral part of this industry, providing consumers with accessible and self-administered treatments for common ailments. In Australia, the regulation of OTC drugs is a crucial aspect of safeguarding public health and maintaining high standards of safety and efficacy.(1) The Australian regulatory framework for OTC drugs is designed to protect consumers from potential risks associated with the use of these medications. It ensures that only products meeting stringent quality, safety, and efficacy standards are available without a prescription. The Therapeutic Goods Administration (TGA), Australia's regulatory authority for therapeutic goods, plays a central role in overseeing the registration and regulation of OTC drugs in the country.(2) As per the report of 2018 by Association of the European Self-Medication Industry, Facts and Figures, Australia has been recognized as world's 3rd highest rising marketplace in sales of self-medication and the market is valued at over AUD 2 billion. For minor health conditions medication such as ache, fever, nose congestion, sore throat, fungal infection and stomach upset are sold under the name of OTC.(2) OTC medications are sold in Australia in three distinct ways in accordance with Australian law. Those are

1. **Pharmacist only:** E.g.:Mild steroid-containing creams for skin irritations and inhalers.
2. **Pharmacy medicine:** E.g.: Symptoms of allergy and diarrhea.
3. **Medicine for general sale:** E.g.: Cough and cold remedies

On the Australian Register of Therapeutic Goods (ARTG), some medications are "registered," while others are "listed," "listed assessed," or other variations. OTC medications are evaluated for quality, safety, and efficacy and registered and certified by the Australian Therapeutic Goods Administration (TGA) with an AUST R (AUST Registered) number. OTC drug registration application levels: N1, N2, N3, N4, and N5. Numerous factors play a role in application-level choice. These medications often have an intermediate degree of risk and make therapeutic claims for the treatment or prevention of illness. (3) In this article, we will explore the current regulatory requirements for filing OTC drugs in Australia. We will examine the key steps and processes involved in obtaining approval for these medications, including the necessary documentation, quality controls, and safety considerations. Furthermore, we will discuss the responsibilities of manufacturers, importers, and sponsors in complying with the regulatory framework, as well as the ongoing post-market surveillance to ensure ongoing safety and efficacy.

TGA therapeutic classification of medicine
ARTG Registered or ARTG R
OTC medications are examined for quality, safety, and efficacy and registered with and certified by the Australian TGA. They have an AUST R number. Registered medications include chemicals that pose a higher risk. Antihistamines and medications for minor discomfort are a few examples of registered over-the-counter medications.

ARTG Listed or ARTG L

These are pre-approved and contain low-risk ingredients with low-risk health privileges.Drugs that do not comply with guidelines may suspend or cancel their listing. For instance, OTC medicines include some toothpaste and sunscreens(4).

TGA ORGANIZATIONAL CHART

Classification of OTC medicine application form for registration

Applications for OTC medications are divided into risk categories. For applications of novel medications, there are five risk levels: N1, N2, N3, N4, and N5. The numerous OTC medicine application levels and the important application requirements are defined by the OTC application classification.

N1 application

This level of application comprises of 'clones' and flavor/fragrance and color variants. They have to get registered in ARTG. This application has reduced requirements for supporting data as the proposed medicine to an original medicine. (Refer table No. 1)

Criteria

1. Authorization for TGA to access the parent medicine information from file and TGA records.
2. Details on the permitted difference from the parent medicine and approval from parent medicine sponsor
3. Evaluation of safety, efficacy and safety data
4. Product is identical to parent medicine
5. Assurance to comply for N1 application in an OTC medicine
6. Product name does not include an umbrella segment specified as requiring a higher level of assessment.
7. The evaluation includes compliance with RASML (Required Advisory Statements for Medicine Labels) and/or Med Safe Labelling Statements Database.

N2 application

OTC monograph is applied under the application, OTC New Medicine N2 applications can be filed with fewer criteria for data evaluation if they meet the standards of a product-specific OTC medicine monograph and the requirements outlined in this document. According to the Australian Regulatory Guidelines for OTC Medicines (ARGOM), sponsors are obliged to provide a comprehensive data set for their product. Only medications that contain the exact Australian Approved Name (AAN) component stated in the monograph are covered under the monograph. In case of N2 application, the shelf life of the finished product, direction for use and warning, should be as per the OTC monograph (Refer table No. 1). Drugs falling under N2 category might comprise those medicine which is used for cough, pain relief and antiseptic creams and cold, etc. This application involves the minor necessities for data assessment by the agency and subsequently less time for evaluation. Along with the supporting data with an application, the sponsor needs to finish an "Assurance to comply with an OTC new medicine N2 application" approving that the product meets the defined requirements. And OTC drug monograph does not include the risk associated with the umbrella branding segment. (8)Active premixes are not allowed unless specifically indicated in the OTC medication monograph for that product.

a. The active ingredient premix finished product manufacturer acceptance standards must be in compliance with those detailed in the pertinent specialized OTC medication monograph.
b. The supplier is required to control the individual components in any active premixes in accordance with pertinent and up-to-date BP, Ph. Eur., or USP/NF monographs.(9)

For OTC N2 applications, the following must be submitted:

1. A completed application form via TGA eBusiness Services (eBS)
2. completed product specifications at release and expiration
3. Colour label(s) (as stated under labelling)
4. Completed assurances document • Certificates of analysis (C of A) for two batches of the completed product
5. Details of calibrations used on any supplied measuring device (if relevant) Post-market monitoring of medicines is accepted via the N2 route will be conducted by the TGA to increase the assurance about the sponsor's compliance with requirements. (10)

N3 application

This is other than those, a new generic drug application in levels N1, N2 or N4. These are the OTC generic medicines which do not require safety and efficacy data in support of medicine. In some cases, it's mandatory to provide therapeutic equivalence data or bioequivalence data to validate therapeutic equivalence data or bioequivalence data with the parent drug. But this application requires the documents of quality data. (11)

N4 application

Application for a generic medicine which demands evidence of supporting safety and effectiveness, or an explanation for not providing such evidence. This must be included with a risk related to a segment of umbrella branding (higher level of assessment). Evaluation of quality data is mandatory; efficacy and safety data have to be provided or justification for not providing the data. (12)

N5 application

The application for a novel drug that is an expansion of a "generic category" must include the following:
1. API
2. Innovative drug indications
3. New strength
4. New dosage form
5. New combination medicine
6. Various patient populations

This application requires an efficacy and safety data and the quality data of the medicine which has been previously assessed by the agency. (13)

DISCUSSSION

Stringent Regulatory Standards

The Therapeutic Goods Administration (TGA) has set strict rules for the regulatory procedures for submitting OTC medications in Australia. Before being made available to the general public, OTC medications must adhere to the appropriate quality, safety, and efficacy requirements. The TGA uses a risk-based methodology to assess the advantages and dangers of each product, taking into account a number of elements including the active components, dosage forms, indications, and planned labelling.(14)

Quality standards

In order to guarantee that pharmaceutical goods, including OTC medications, are consistently manufactured and regulated to satisfy their quality requirements, GMP is a set of quality assurance and control principles and practices. GMP regulations include a range of manufacturing-related topics, including facility design and upkeep, employee training, equipment calibration and maintenance, documentation procedures, quality control testing, and storage and distribution conditions. The TGA demands that OTC medications satisfy high quality requirements, and following good manufacturing practices (GMP) is essential to guaranteeing that quality is maintained throughout the production process. The manufacturing facility for OTC pharmaceuticals must be planned such that the goods are produced in a sterile and regulated environment. This covers factors like controlling the temperature, humidity, and air quality. To guarantee that they understand and can successfully follow GMP rules, all people engaged in the manufacturing process must get the proper training. Every machinery utilized in the production process has to be routinely serviced and calibrated to guarantee that it is operating properly and delivering consistent results. All components of the production process, including batch records, test findings, and quality control procedures, must be thoroughly documented by manufacturers. To guarantee that the goods fulfill the requirements for safety, quality, and efficacy, manufacturers must conduct routine quality control testing. OTC medications must be kept in the proper conditions to guarantee that they are stable and effective for the duration of their shelf life.(15)

Safety standards

In Australia, OTC drug regulation is primarily focused on safety. On the basis of the active components, dosage forms, and suggested indications, the TGA assesses the safety profile of each product. The findings of preclinical and clinical trials, as well as any complete information on the product's safety, must be provided by the manufacturer. The TGA assesses this information to decide if the product's advantages exceed any possible hazards. The TGA evaluates the safety information to decide if the product's advantages exceed any possible hazards. To ensure safe use, extra cautions, warnings, or contraindications may be required. After a product is registered, the TGA uses post-market surveillance to keep an eye on its efficacy and safety. This makes it more likely that any safety concerns will be found and quickly resolved. OTC medications that have been registered and approved by the TGA have an AUST R number that is used to identify the product and must appear on the labelling and packaging of that product.(16)

Efficacy Standards

To make sure that OTC medications are successful in treating the illnesses for which they are prescribed, the TGA evaluates their efficacy. Scientific proof of the drug's efficacy must be provided by the manufacturer, often through carefully planned and monitored clinical studies. To ascertain if the product has shown a statistically significant and clinically relevant impact, the TGA assesses this evidence. The therapeutic category and the specific claims made by the product influence the effectiveness requirements.(17)

REGISTRATION PROCEDURE

OTC medicine licensing in Australia is a thorough and meticulous process that entails numerous crucial procedures. A thorough dossier covering scientific information, preclinical and clinical trial findings, details on the product's composition, the manufacturing process, and quality control procedures must be assembled by manufacturers, importers, or sponsors. The Therapeutic Goods Administration's (TGA) review is predicated on this dossier.

Creating a dossier

It is necessary for manufacturers, importers, or sponsors to put up a thorough dossier that contains extensive information on the OTC medication. This contains information on the active components, dose options, suggested usage, intended use, and any side effects of the medication. Additionally, details on the drug's formulation, manufacturing procedure, stability tests, packaging, labelling, and product information should be included in the dossier.

Determination of precise application level for OTC medicine submission

Applications for OTC medications are categorized based on their level of risk. Each of the risk levels has a corresponding application category and evaluation process. Less supporting information is needed for applications with lower risk levels than for applications with higher risk levels. There are a number of advice tools available to control the application category/correct risk level, including the following:

1. OTC application categorization framework
2. OTC application route for umbrella branded medicine
3. Flowchart for OTC application placement
4. A placement question and response tool for OTC applications (19)

Manufacturers' Responsibilities

OTC medicine manufacturers in Australia are held accountable for adhering to the legal requirements. They are in charge of making sure that their goods adhere to the essential requirements for quality, safety, and efficacy. To produce the scientific evidence needed to back the claims made for the product, rigorous research and development, including preclinical and clinical studies, must be conducted. Good manufacturing practices (GMP) must be followed by manufacturers as well to guarantee the reliability and consistency of their goods' quality. Additionally, it is the duty of producers to put together thorough dossiers that include all pertinent details about the medicine, such

as its composition, the manufacturing process, stability studies, and quality control procedures. The Therapeutic Goods Administration's (TGA) review is built on the information included in these dossiers. Additionally, manufacturers must continue to help the TGA in its post-market surveillance of their goods by quickly reporting any adverse occurrences or safety concerns.(22)

Importers
Importers are required to confirm that the goods they bring into the country were produced in GMP-compliant facilities. This guarantees that the goods adhere to the same high standards as those produced locally. The implementation of suitable quality control procedures throughout the production of imported goods is the importers' responsibility. This promotes the effectiveness and safety of over-the-counter medications. Importers are responsible for making ensuring that the imported items' labelling, packaging, and product information adhere to Australian regulatory standards. Ingredients, dosage forms, indications, and any applicable cautions or warnings must all be correctly represented. Before items may be sold and distributed in Australia, importers must work closely with manufacturers to gather all required paperwork and make sure the products are registered with the Therapeutic Goods Administration (TGA).(23)

Sponsors
In Australia, sponsors are essential to OTC medicine regulation compliance. On behalf of the producer or importer, sponsors are in charge of filing the product registration application to the TGA. Sponsors are responsible for making certain that the product's registration dossier is correct and comprehensive and contains all the TGA-required scientific data, paperwork, and information. Sponsors must make sure that continuing compliance with regulatory standards is maintained. This involves immediately informing the TGA of any updates or changes, such as adjustments to the product's composition, production method, labelling, or safety information. The TGA examines pertinent scientific evidence, and its main duty is to assess the product's safety. The Australian Regulatory Guidelines for OTC Medicines (ARGOM) were created by the TGA to help sponsors of OTC medications comply with regulatory obligations. These guidelines offer comprehensive details on the necessary conditions for a successful OTC drug application. Sponsors can guarantee that OTC medications sold in Australia adhere to the TGA's regulations and meet the essential criteria for safety, quality, and efficacy by carrying out their obligations. Sponsors must also actively monitor the product's safety and effectiveness in order to assist post-market surveillance initiatives. Monitoring adverse event reports, responding to any product complaints or concerns, and working with customers and healthcare providers to maintain product safety and quality are all part of this process.(24)

Labelling
The General requirements for the labels of OTC medicine must fulfil the requirements of TGO 90 as it is considered as a means of consumer advertising. A list of medications coupled with an advisory statement is supplied in RASML. The advice or warning statement must be on the pharmaceutical label.

Basic Requirements for Label
1. Text: English and unmistakable and unobscured
2. Text size: not less than 1.5mm
3. Color: Contrasting colors with the background
4. Unit of measurements: Metric unit (25)

CHI (Critical Health Information) for Registered OTC Medicine
CHI is compulsory for registered non-prescription medication, but CHI is not mandatory for listed non-prescription medicine. The CHI must be represented in subsequent order: (Illustrated in figure 5 and 6)
1. Active ingredients
2. Indications
3. Warning

4. Direction for use
5. Storage information e.g.: Keep out of children's reach, and do not take
6. Storage condition e.g.: store below 25°C in tamper-proof pack
7. Details of sponsors and distributors
8. Other information (as per the requirements): "Pharmacist Only Medicine", "Pharmacy Medicine" and allergic condition
9. CHI must be displayed in one color—black or another dark shade—against a backdrop of either white or shrinking pixels.
10. While medication labels for registered complementary medicines are submitted and assessed by TGA, labels for listed complementary medicines are not submitted at the time the drug is listed. A sponsor must make sure the image, logo, comparative promotional statement, and expert suggestions comply with TGCA. A disclaimer like "gluten-free" or "sugar-free" needs to be accurate. In addition, label claims like "new" or "advance" are permitted for a maximum of 12 months after the product debut.(26)

Registration of OTC drugs
The OTC application levels have defined timeline and submission requirements. The supporting documents and the timelines will apply based on the risk of OTC medicine (Higher risk and lower risk).The application is submitted electronically through Business services, then it the application get registered as the OTC medicine. The applications are screened to determine whether it is complete and meets the requirements for an effective application. If the application is effective, it is accepted for evaluation. The agency might request information from the applicant to address issues that are identified. Based on the evaluation the delegate of the TGA decides whether to register the medicine on ARTG or not. [18]Safety of OTC medicine product in Australia: The TGA has a complex mechanism for keeping track of medicinal goods available on the market. in order to reduce the risk and get most of the benefits to the consumer. The programs are as follows:

1. The mechanism for reporting issues allows for the reporting of product flaws and drug side effects.
2. TGA labs' random and focused sampling of permitted items
3. Desk-based audits of listed items that are random and focused
4. GMP audits
5. Controls for advertising of pharmaceutical products (29)

POST MARKET SURVEILLANCE
The TGA encourages manufacturers, sponsors, healthcare providers, and consumers to report any adverse events or side effects related to OTC medications. Identification of possible safety issues requires the use of this information. To make sure OTC medications fulfill quality criteria for purity, potency, and stability, the TGA randomly samples and tests them. In the event that quality problems are found, the required measures are followed, which may involve product recalls. The TGA supervises OTC medicine labelling and packaging to make sure it complies with legal standards. This contains precise component lists, understandable usage guidelines, and pertinent cautions. The TGA performs post-market evaluations of particular OTC medication classifications or specific products on a recurring basis. These evaluations evaluate the products' continued safety and efficacy and, if required, may result in regulatory measures including label revisions, safety alerts, or withdrawal from the market. The TGA also keeps an eye on OTC medicine advertising and promotion to make sure that no fraudulent claims are being made or that customers are being misled. If a problem with an OTC drug's safety is discovered, the TGA may issue recalls and safety alerts to take the product off the market or warn the public and medical professionals of possible dangers.(30)

Advertisement
Australian Self Medication Industry (ASMI) controls OTC drug advertising in Australia. The Therapeutic Goods Act 1989 and Regulations, the Competition and Consumer Act 2010, and the TGACC (Therapeutic Goods Advertising Code Council) all specify the requirements for therapeutic good advertisements in Australia. According to the current regulations, in order to be promoted on Australian websites, therapeutic products must adhere to the

Therapeutic products Advertising Code (TGAC). The WHO: Ethical Criteria for Medicinal Drug Promotion 1988, which TGAC is dependable with, calls for the submission and approval of ads.In contrast, dangerous signs cannot be marketed unless a previous exemption clearance has been acquired. TGAC sets required standards such as brand name, list of components, permitted indications, cautious remarks, and warnings for insertion in advertisements(31)

CONCLUSION

TGA is enhancing its flexibility with regard to the registration or listing of OTC medications as a result of the overview of reorganizations made in response to the MMDR through public, targeted consultation, and internal consultation for registered and listed medicines by introducing approval process, combined lists of approved, list of allowable indications, permitted ingredients, overview of timeframes for the approval, guidelines for labelling, CHI for registered OTC medicine, stability and usage of the advertising material to designate a invention has been measured as safe and effective Hence by understanding the classification and criteria involved in OTC applications, the selection of an appropriate application for particular OTC drugs can be made in Australia.

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Table 1: Overview of classification of OTC application as per criteria, requirements, time and application fees. (6)

Application-level with the risk level	Definition	Application data requirements (CTD modules)	Time (Days)	Application fee	Evaluation fee
N1 (Negligible risk)	'Clones' and flavor/fragrance/color variants or parent medication	M1	45	$ 1,650	$ 4,080
N2 (Negligible risk)	As per the OTC monograph	M1, M2 and M3	55	$ 1,650	$ 5,800
N3 (Low risk)	Not an N1, N2, or N4 application	M1, M2 and M3	150	$ 2,650	$ 8,930
N4 (Low risk)	Previously not registered API	M1, M2, M3, M4 and M5	170	$ 3,870	$ 14,800
N5 (Moderate risk)	A novel chemical compound, active ingredient combination, new indication, strength, or dose form Use instructions Patient population	M1, M2, M3, M4 and M5	210	$ 5,740	$ 21,900

Table 2: Administrative and dossier matrix to file the different OTC medicine application. (18)

Modules:	N1	N2	N3	N4	N5
Module 1					
Cover letter	✓	✓	✓	✓	✓
Response to request for information	✓	✓	✓	✓	✓
Patent certification	✓	✓	✓	✓	✓
Product information and package insert	✓	✓	✓	✓	✓
Consumer medicine information	✓	✓	✓	✓	✓
Label mock-ups and specimens	✓	✓	✓	✓	✓
Information about the experts				✓	✓
Specific requirements for a different type of application	✓	✓	✓	✓	✓
Literature-based submission of documents				✓	✓
Co-marketed medicine declaration	✓	✓	✓	✓	✓
OTC medicine assurances	✓	✓	✓	✓	✓
Umbrella branding assessment				✓	✓
Master files and certificate of suitability			✓	✓	✓
Compliance with meetings and pre-submission process					
Summary of biopharmaceutic studies				✓	✓
Information related to the pediatrics					
Foreign regulatory information			✓	✓	✓
Module 2:					
Introduction			✓	✓	✓
Quality overall summary				✓	✓
Non-clinical overview				✓	✓
Clinical overview				✓	✓
On-clinical has written and tabulated summaries				✓	✓
Clinical summary				✓	✓
Module 3:					
Drug substance			✓	✓	✓
Drug product			✓	✓	✓

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Drug product manufacture			✓	✓	✓
Control of excipients			✓	✓	✓
Control of drug product		✓	✓	✓	✓
Analytical procedure			✓	✓	✓
Validation and test methods			✓	✓	✓
Batch analysis		✓	✓	✓	✓
Control of drug products			✓	✓	✓
Container closure system		✓	✓	✓	✓
Stability			✓	✓	✓
Module 4				✓	✓
Module 5				✓	✓
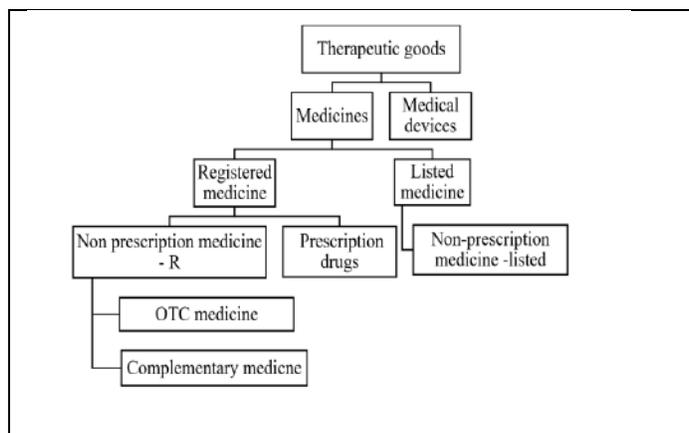
Figure 1: Therapeutic classification of medicine as per TGA(4)
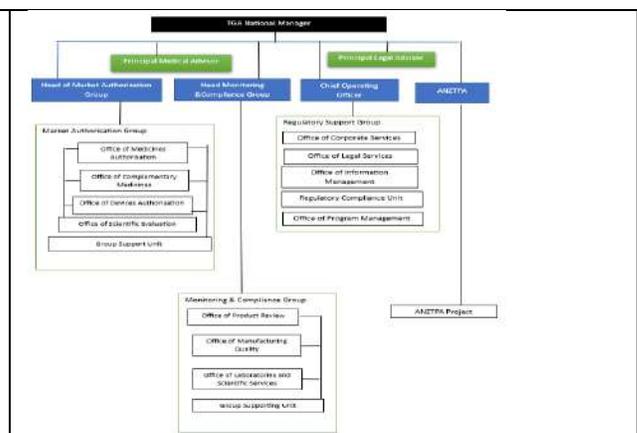
Figure 2: Organizational structure of Therapeutic Goods and Administration(5)
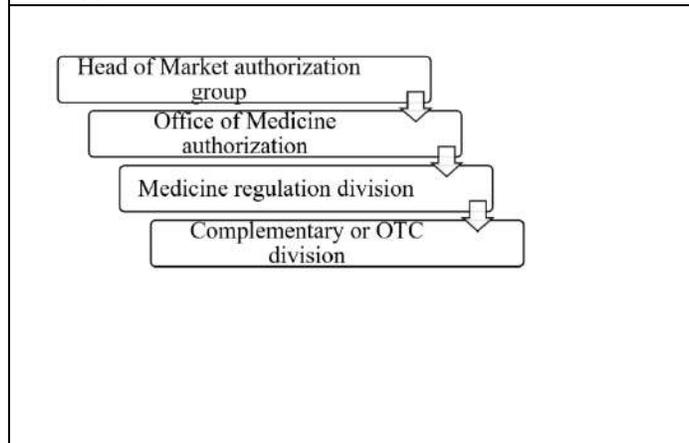
Figure 3:Organizational structure for the Head of Market authorization group in TGA(5)
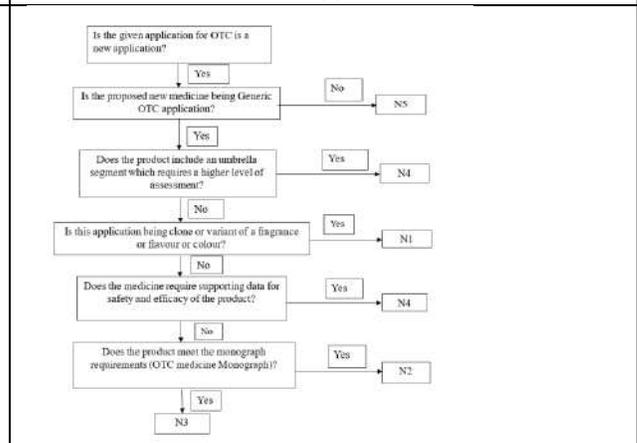
Figure 4: Criteria to select the appropriate application for an OTC drug(20)

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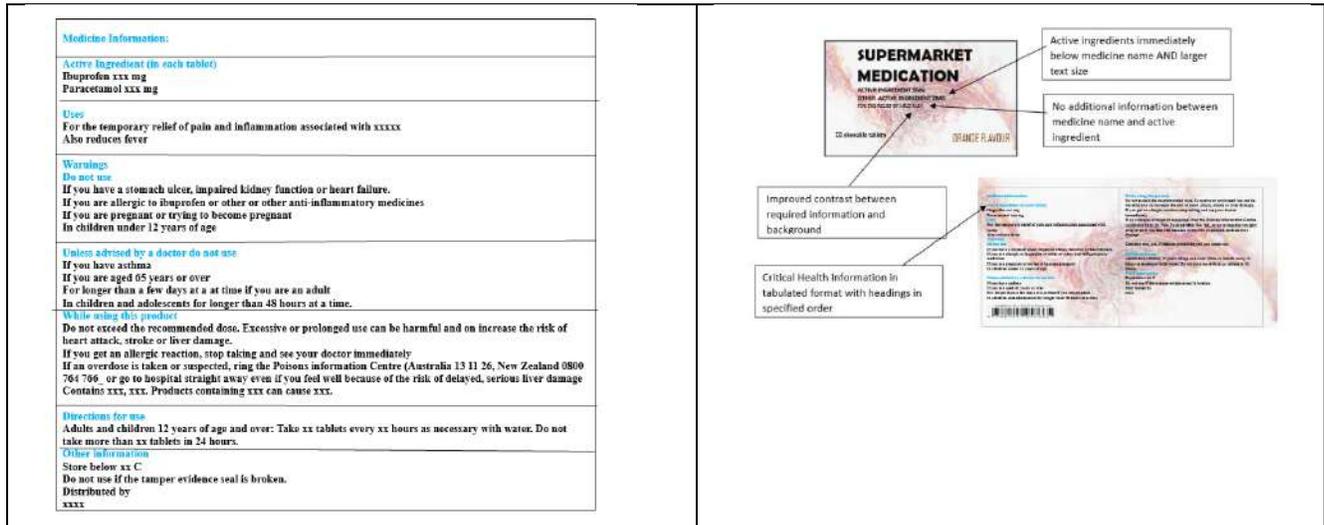
Figure 5: Fact label for OTC medicine with CHI(27)

Figure 6: Overview of non-prescription OTC medicine label for Australia (28)
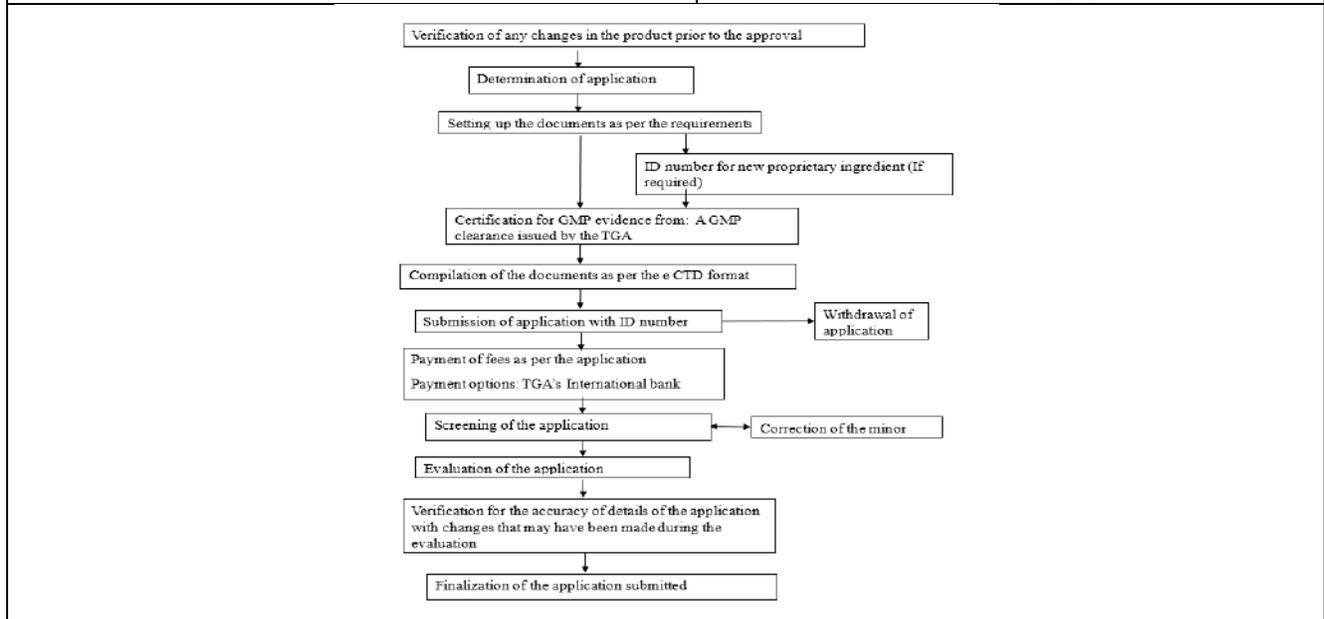
Figure 7: Application process involved in the registration of the OTC drug.(21)

REVIEW ARTICLE

A Review on Medicinal Plants at Risk in Andhra Pradesh

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ABSTRACT

Andhra Pradesh, which is located in the middle of the eastern half of the Indian peninsula between 120 41' - 190 54' N Latitudes and 760 46' - 840 45' E Longitudes. The state's features include hills that rise almost about 1500m altitude from sea level, contain a rich and valuable flora, and forests cover 23% of the geographical land. According to Andhra Pradesh biodiversity board 22 threatened plant species are identified and enlisted based on IUCN Red List and few of them are endemic species too. There is a need to conserve the threatened, endemic plant species it is important to protect their natural habitats, and forests require further safeguards due to their rich biological variety. For the purpose of Institute and Exsited conservation, a thorough inventory of the plant diversity in the state's forests is required. The primary goal is to protect Andhra Pradesh's genetic resources and flora for future generations. In this literature we mentioned threatened Plant species of Andhra Pradesh, distribution, IUCN status and their medicinal importance and reported activities. The following points need to be focused on future work lines are contributing to the study of their protection, discovering indigenous species, their significance for trade and medicine, is described in this literature as having a list of threatened species.

Keywords: IUCN, Biodiversity, Endemic species, Threatened species, *In situ* and *Ex situ* conservation

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INTRODUCTION

The usage of medicinal plants to prevent disease and maintain health has been mastered by cultures all around the world over the centuries [1]. For rural and indigenous people, these are a crucial source of subsistence. As medicinal plants gain more scientific and financial attention the burden on wild plant populations increased. Many species used for medicine are now in danger of extinction due to overharvesting. Need is arise to study and preserve medicinal plant species. The indigenous peoples who have relied on traditional medicines for decades or millennia often find that they are no longer available due to commercialization. The challenge is being embraced by government, Private, NGO organizations all across the world, they recommending new procedures and policies to safeguard our last remaining medicinal treasures in the wild areas so that they can protect our future generations through the Global Convention on Biological Diversity, the Convention on International Trade in Endangered Species, and non-governmental organizations like International Standard for Sustainable Wild Collection of Medicinal and Aromatic Plants (ISSC-MAP). The International Union for Conservation of Nature (IUCN), formed in 1948, is the biggest and most renowned global conservation organization. Its main office is in Gland, Switzerland [2]. Around 1,400 Member organizations, 15,000 specialists, and 11,000 volunteer experts from 160 different countries make up the IUCN, which has more than 1,200 members from governmental and non-governmental organizations. It works on studies, field projects, campaigning, advocacy, training, data collection, and analysis of endangered species. A central secretariat, which also provides a range of services and oversees initiatives for the preservation and ethical utilization of biological diversity globally, manages the IUCN Program.

IUCN's objectives [3]
The objectives pursued by the International Union for Conservation of Nature are as follows:
1. To offer scientific information on the condition of species and subspecies on a worldwide scale.
2. To address the issues and raise awareness about the extinction of species and biodiversity.
3. To design a layout for biodiversity preservation.

The IUCN Red List [4,5], which ranks the status of species around the world. The goals of these programs include global conservation of plant species, stopping habitat loss, re establishing ecosystems, and enhancing human wellbeing. Countries or organizations create a number of Regional Red Lists that evaluate the risk of extinction for species within a given political control unit. A precise set of criteria is used by the IUCN Red List to assess the rate of extinction for thousands of species and subspecies.

According to the IUCN Red List threatened plant species are categorized as [6]
- **Extinct (EX)** No one who is still alive is known
- **Extinct in the wild (EW) Only known to exist as a naturalized population outside of its historical area or in confinement.**
- **Critically endangered (CR)** Extremely high risk of extinction in the wild, population decline (greater than 90% over the past ten years), population size (less than 50 mature individuals), and quantitative analysis showing the probability of extinction in the wild in at least 50% in their ten years are all factors that contribute to this speciesgreat danger of going extinct in the wild.
- **Endangered (EN)** High risk of extinction (or) disappearance in the wild
- **Vulnerable (VU)** Potential for extinction (or) disappearance in the wild
- **Near threatened (NT)**(or)**Almost in danger** Likely to soon become critically endangered.
- **Least concern (LC) Lowest danger, doesn't meet the requirements for a riskier category. This category includes taxa that are widespread and numerous.**
- **Data lacking (DD) (or) Data deficient (DD) There isn't enough data to predict the likelihood of extinction.**
- **Not assessed (NE) (or) Not evaluated has not yet been evaluated against the demands.**
  India gained notoriety among ancient civilizations [7] as a significant source of therapeutic herbs.

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The vast majority of the aromatic and medicinal plants used in India's forests are gathered for use as raw materials in the manufacture of pharmaceuticals and perfumery products. Ayurveda contains a list of about 8,000 herbal treatments. Unfortunately, there is a worrying rate of loss of many significant plants and much of the ancient knowledge. Traditional herbal medicine systems have reached a highly critical stage as a result of the quick deforestation that is reducing the supply of raw pharmaceuticals. Thus, it is crucial to conduct scientific research into traditional medicines, develop new medications through bio prospecting, and maintain a strict preservation program for the relevant medicinal plants. The group established by IUCN members in India is known as the Indian National Committee (INC). IUCN HQ Letter No. IN/4/NC55 dated November 14, 2001[8] provided the IUCN Council with official recognition with 31 members as of right now, the Committee is made up of representatives from the Indian government, academic institutions, and both domestic and foreign NGOs. The IUCN is a global, independent, nonprofit organization in India. India contributed significantly to the 2012 World Conservation Congress (WCC), which took place on the island of Jeju in September. The summit's agenda, which addressed every aspect of conservation, was led by Prof. MS Swaminathan, the architect of the Indian green revolution, and Dr. Ashok Khosla, president of the IUCN. Through a Memorandum of Understanding (MoU) signed with the Indian government, which joined the IUCN as a State Member in 1969 through the Ministry of Environment and Forests (MoEF). In New Delhi, the IUCN India Country Office was founded in 2007 [9].

India, which is the ninth most diverse country in the world in terms of plant species, is one of these countries. With 10 separate biogeography zones, India is also well-endowed in terms of ecological diversity. Regarding species, ecosystems, and genetic variability, India exhibits extraordinary diversity. In just 2.5% of the planet's surface, there is more than 7% of the world's biodiversity. This diversity of habitat-providing landforms and climates can be credited for this richness and offer habitats in a wide range of environments, including tropical, temperate, alpine, and desert. India is considered to be home to over 45,523 plant species, which accounts approximately 11.8% of the world's flora is found here. Among these, there are around 17,500 flowering plants, 4,950 of which are native as well. India is home to 32% of the world's endemic plants[10].Among India's 123 rich and bio-diversified states, Andhra Pradesh is regarded as one of the richest and endemic natural flora and fauna are mostly influenced by the soil, climate, and relief. The two biggest rivers flow through the state are Krishna and Godavari. Forest management, conservation, and protection are all responsibilities of the Andhra Pradesh Forest Department. The state of Andhra Pradesh is situated in the center of the eastern Indian Peninsula[11]. 22,862km²of Andhra Pradesh was covered with the forest. Tropical forests are abundant in the Eastern Ghats region, whereas shrub vegetation is more prevalent in the Deccan Plateau, where the vegetation is sparser. The Bay of Bengal borders Andhra Pradesh to the east, Tamil Nadu to the south, Karnataka to the west, and Maharastra, Chattisgadh, and Orissa to the north. Andhra Pradesh contains 26 Districts, which are grouped into three zones administratively[12]

1. Costal Andhra with 12 districts (i.e., Kakinada, Dr. B.R. Ambedkar Konaseema, East Godavari, West Godavari, Eluru, Krishna, N.T.R., Gunturu, Palnadu, Bapatla, Prakasam, Sri Potti Sri Ramulu Nellore).
2. Uttarandhra with 6 districts (i.e., Srikakulam, Parvathipuram Manyam, Vizianagaram, Alluri sitharamaraju, Anakapalle, Visakhapatnam).
3. Rayalaseema with 8 districts (i.e., Kurnool, Kadapa, Nandyala, Ananthapur, Sri Satya Sai Y.S.R., Annamayya, Tirupati, Chittoor).

In order to protect genetic resources for future generations, the Andhra Pradesh Bio Diversity Board designates 22 plant species as being under threat and requiring in-situ or ex-situ conservation[13]. Botanists, scientists, environmentalists, agriculturalists, foresters, and local people all need to pay attention for conservation of medicinal plants through suitable micro propagation methods. IUCN status, common or vernacular name, family, species and endemism of various threatened plant species of Andhra Pradesh listed in Table 1. Medicinally useful threatened plant species distribution in different regions of Andhra Pradesh and researchers proved the activities of some threatened plant species were described as follows.

Andrographis beddomei is primarily found in Prakasam district (Diguvametta), Kurnool Hills Kadapa district (Kurnool Hills) and Lankamalai[31].Traditional medicine uses andrographis species extensively for the treatment of malaria, dyspepsia, influenza and respiratory infections.

Brachystelma glabrum is primarily found in the northern most portion[32] of the Srikakulam district, in the deciduous woods and woodlands of the Donubayi, Palakonda, Seetampet regions, Jalanthrakota Reserve Forest (Srikakulam), and Pinjarikonda Reserve Forest (East Godavari), The antioxidant activity [33] of Brachystel maglabrum was reported by NqobileP. et al.

Brachystelma penchalakense is primarily found[34] in the Nellore district (Penchalakona) of and the Asia-Tropical regions. Numerous Brachystelma species are used extensively in herbal remedies because they are nutritious and primarily devoured by herbivores.

Brachystelma volubile is primarily found in the Rayalaseema (Chitoor district) Nallamalais, Lankamalleswaram, Papavinasam and Tirumala Hills, this species has a restricted range. The clinical anti diabetic activity of salam leaves (*Eugenia polyantha*) and sambiloto leaves (*Andrographis paniculata*) in Type 2 diabetic patients has been the subject of a preliminary investigation. The study of andrographolide's bioactivities in skin cancer cells and skin exposed to UV radiation as well as the optimization of production parameters for andrographolide-loaded nano emulsion creation by micro fluidization.

Bupleurum andhricum is primarily found in the Northern Eastern Ghat's, Sunkarietta, Laxmipur (Visakhapatnam District), Palakonda, Rampachodavaram (East Godavari District), and Devagiriparlakimidi (Srikakulam District). Bupleurum is used to treat respiratory illnesses such as pneumonia, bronchitis, the common cold, swine flu, and the flu (influenza). Bupleurum is sometimes used to treat gastrointestinal issues like indigestion, diarrhoea, and constipation. Bupleurum extracts or isolated components (mostly saiko saponins) were the subject of in vitro and in vivo studies[35] that shown strong anti-inflammatory, anti-ulcer, and immune modulatory effects. Hepato protective, antitussive, antispasmodic, diaphoretic, antioxidant, and antibacterial properties are among the additional activities. Due to their strong structural resemblance to podophyllotoxin, some lignans from the Bupleurum species may be effective anti-mitotic medicines in the treatment of cancer by inhibiting the production of microtubules.

Boswellia ovalifoliolata is primarily found in the Seshachalam Hills and Eastern Ghats (Palakonda). In addition to its commercial significance as a plant that produces fragrant resin, this species of plant's extract is traditionally used to treat rheumatic pain, and its wood is specifically employed in the toy business. Two novel macrocyclic diaryl ether heptanoids, ovalifolio latin A and B, were discovered by Reddy et al. in this species and demonstrated antibacterial activity. In addition to being poisonous to non-target mosquito fish, backswimmers, and water bugs, *Boswellia ovalifoliolata* essential oil is a safe larvacide[36] against six mosquito vectors that are significant for public health.

Caralluma indica is primarily found in the Nellore District which exhibit antibacterial and antioxidant properties. Additionally, a variety of Corallium species have been mentioned in traditional medicine for the treatment of various ailments[38] like antimicrobial, antifouling, antibacterial, antioxidant, anticancer antibacterial, antifungal, anti-larva,fungicide, pesticide, perfumery antihypertensive, increase HDL and decrease LDL cholesterol.

Chrysopogon velutinus majorly distributed in Kadapa district and used in Folk Medicine

Cycas beddomei. synonym is *Cycas circinalis*. Species is primarily found Seshachalam Hills[39] (Tirupati Hills), Srikakulam District, Kadapa District, East Godavari, West Godavari, Visakhapatnam, vizianagaram Districts, and Chittoor Districts are home to the only known global endemic population of this species. The male cones are removed by the local tribal because they are thought to have medicinal powers and are a key component in tonics that promote youth. This plant's male cones are used to treat rheumatoid arthritis and muscle discomfort since they are thought to have narcotic qualities. To cure skin conditions such cuts, sores, and boils, the seeds are applied as a poultice [40].

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Cycas sphaerica **synonym** is *Cycas circinalis* Linn. var. orixensis Haines. The main distribution areas for this plant species include the [41] Nallamalai Forest Area, the Kurnool district, Srikakulam, East Godavari, and Kadapa. A significant ornamental plant is the cycad. They are frequently planted in gardens in metropolitan settings. In religious events as well as the preparation of bouquets and floral decorations, leaves are used. Leafy vegetables made from young leaflets are also consumed. Sago flour is occasionally made with piths as an adulterant in baby meals. Male cones are employed as bed bug and mosquito repellents. Idlis, cakes, and other foods are made from the endosperm of mature fruits [42].

Dicliptera beddomei this plant species majorly distributed inKurnool district

Dimorphocalyx Kurnoolens is majorly distributed in Nallamala forests, Kurnool district. This is employed as an antidote for scorpion and snake bites[43].

Eriolaena lushingtonii is mostly found in several portions of the Andhra Pradesh, Eastern Ghats, as well as some regions of the Rayalaseema, Kadapa, and Ananthapur (Chinnapalle) districts. For dog bites, a decoction is given orally and an external application of stem bark extract is made. Malaria can also be treated using stem extract. The plant's unnamed component is used as an antidote[44] for scorpion stings and snake bites.

Hildegardia populifolia this plant species majorly distributed in Srikakulam district, East Godavari.The flowers[45] are visited by several bird species, such as the red-vented bulbul, rufous-backed shrike), blue-tailed bee-eater, and stork-billed kingfisher, some of which are predators of the bee.Barks of the stem,leaves are used to treat dog bite and malaria. Paulsamy et al., reported the in vitro antifungal[46] activity of leaf and stem bark extracts.

Kalanchoe cherukondens **is** majorly distributed in [47] Cherukonda hills (Visakhapatnam district)Kalanchoe species are used to treat rheumatism[48], depression, anxiety, insomnia, inflammation.

Memecylonmadgolense majorly distributed in Batrepalli forest, (Ananthapuramdistrict) Talapula forest, Mangapatnam forest (Kadapa district), Memecylon species having anti diabetic[49],antiinflammatory, antioxidant, anticancer and antimicrobial activities.

Pterocarpus santalinus majorly distributed in the Talakona Reserve Forests, Tirumala Hills, Sesachalam Hills (Chittoor districts), Veligonda (Kadapa district). *Pterocarpus santalinus* is primarily distributed. The species is used for its timber commercially. Japanese musical instruments[51] are made from red sanders' heartwood, which is also used as an astringent, tonic, bitter, sweet, cooling, analgesic, anti-inflammatory, and febrifuge. Chronic dysentery is treated using its decoction. Additionally, it helps with leprosy, ulcers, hemorrhages, burning sensations, vomiting, and other pitta-vitiated illnesses. Traditional herbal medicine[52,53] use *Pterocarpus santalinus* as a diuretic, anti-inflammatory, tonic, hemorrhage, dysentery, aphrodisiac, and anti-hyperglycemic agent, anti helmintic, antipyretic agent.

Rhynchosia ravii [54]This plant species majorly distributed in Talakona hills of Chittoor district. Dry powder of whole plant used to treat peptic ulcers, spleen, heart and blood disorders.

Shorea tumbuggaia majorly distributed in Srikakulam district, Rampa hills of East Godavari districts, tirumala hills chittoor), seshachalam hills, veligonda (kadapa).The species is used commercially for both medicinal and timber applications. Carpentry uses the heart wood. To be utilized as an external stimulant are plant parts. the plant extracts that are used to treat ear pain. As ear drops, leaf juice is employed. The bark has anti-ulcer properties. Resin is found in the stem and is used to make incense. the resin used to treat amoebic dysentery and duodenal ulcers. Native Americans also utilize it as an alternative to arbutus for kids and as an external stimulant [55,56].

Tephrosia calophylla this species distributed in the five districts of Chittor, Kadapa, Kurnool, Nellore and Prakasham[57]. It is dispersed in Sesachalam, Veligonda, Lankamala, and Palakonda. This traditional medicinal species reffered in Charaka Samhita and Sushruta Samhita and its therapeutically used to treat Leprosy, bone

fractures, ulcers, skin conditions, high coughs that cause vomiting, and mental abnormalities. It act as anti-inflammatory agent, anti-hyperglycemic agent and diaphoretic effects. The wood is used in conjunction with other medications to treat scorpion and snake bites. Ganapaty et al. reported the bio organic fraction of the extract's usage as an anticancer and antibacterial agent [58].Adinarayana et al. revealed the acute toxicity and hepato protective impact of *Tephrosia calophylla's* methanolic extract[59]respectively.

Wendlandia gamblei distributed in the mostly north area of (Srikakulam district), deciduous forests and woodlands of Donubayi, Palakonda, Seetampet areas, Jalanthrakota Reserve Forest (Srikakulam District), and Pinjarikonda Reserve Forest (East Godaveri District).Species of Wend land is used as local medicine, source of wood[60], ornamental flower.

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Table 1. Threatened Plant species of Andhra Pradesh

Name of the plant	IUCN Status [14]	Common (or) Vernacular name	Family	Species	Endemism
Andrographis beddomei	Endangered (EN)	False water willows	Acanthaceae	*Andrographis beddomei*	Eastern Ghats
Brachystelma glabrum	Endangered (EN)	Ceropegia Glabra[15]	Apocyanaceae, Asclepiadoideae	*Brachystelma Glabrum*	Southern peninsula India
Brachystelma penchalakonense	Critically Endangered (CR)	Ceropegiapenchalakonensis[16]	Apocyanaceae, Asclepiadoideae	*Brachystelma penchalakonenses*	
Brachystel mavolubile	Critically Endangered (CR)	Nakshathralamokka, Nemithi-gadda	Apocyanaceae, Asclepiadoideae	*Brachystelma volubile*	Eastern Ghats [17], SouthernA.P, India.
Bupleurum andhricum	Critically Endangered (CR)	No Data	Apiaceae	*Bupleurum Andhricum*	Eastern Ghats[18]
Boswellia ovalifoliolata	Endangered (EN)	Kondasambrani	Burseraceae	*Boswellia Ovalifoliolata*	
Caralluma indica	Critically Endangered (CR)	Kundalikombu	Apocyanaceae	*Ceropigieae caralluma*	South western ghats, Peninsular India
Chrysopogon velutinus	Critically Endangered (CR)	No Data	Poaceae	*Chrysopogon velutinus*	South India[19]
Cycas beddomei	Endangered (EN)	Perita, Madhana-Kamashi, Beddome's Cycas, Kondeetha	Cycadaceae	*Cycas beddomei*	
Cycas sphaerica	Critically Endangered (CR)	Spherical Sago[20]	Cycadaceae	*Cycas Sphaerica*	Eastern peninsular India
Dicliptera beddomei	Critically Endangered (CR)	*Diapedium beddomei[21]*	Acanthaceae	*Dicliptera beddomei*	Eastern Ghats [22]

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Dimorphocalyx kurnoolensis	Vulnerable (VU)	Erratandra	Euphorbiaceae	*Dimorphocalyx Kurnoolensis*	Eastern Ghats [23] (Andhra Pradesh)
Eriolaena lushingtonii	Vulnerable (VU)	Malaipuvarasu, GaliBudda, GaliBudaga, Pichipolki, Buddapolki	Malvaceae	*Eriolaena lushingtonii*	
Hildegardia populifolia	Critically endangered (CR)	Dalibuda, delibuda,Poplar Sterculia[24]	Malvaceae	*Hildegardia Populifolia*	Peninsular India [25]
Kalanchoe cherukondensis	Critically Endangered (CR)	No data	Crassulaceae	*Kalanchoe Cherukondensis*	Eastern Ghats(Andhra Pradesh)
Memecylon madgolense	Critically Endangered (CR)	No data	Melastomataceae	*Memecylon madgolense*	Eastern Ghats [26] (Andhra Pradesh)
Pterocarpus santalinus	Endangered (EN)	Red sanders, red saunders, Yerrachandanam, chenchandanam, red sandalwood, Raktachandana, saunders wood.	Fabaceae	*Pterocarpus SantalinusLinn.*	Southern Eastern Ghats mountain range of South India.
Rhynchosia ravii	Vulnerable (VU)	Adivivempalli, Dumpavempalli, GaddaVempalli	Fabaceae	*Rhynchosia ravii*	Eastern Ghats [27] (Andhra Pradesh)
Shorea tumbuggaia	Vulnerable (VU)	sal wood tree, green dammar, tambagam, tambajalar, thamba, Jalari	Dipterocarpaceae	*Shorea Tumbuggaia*	South India [28]
Tephrosia calophylla	Endangered (EN)	Sanders, Agaru, Ruby wood	Fabaceae	*Tephrosia calophylla*	South India [29]
Wendlandia gamblei	Endangered (EN)	No data	Rubiaceae	*Wendlandia gamblei*	Central and peninsular India[30]

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RESEARCH ARTICLE

Pivotal Vulnerability Facets Influencing Static Water Bodies: The Case of Peri-Urban Areas of India

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ABSTRACT

Natural reservoirs, usually referred to as static water bodies, are a vital component in continental regions, offering many purposes as a home for aquatic life, a supply of fresh water, and a collection tank for precipitation. They play a crucial role in sustaining the ecological system and are beneficial for climate adaption in landlocked locations. However, unsustainable human interventions are having a severe impact on these static water bodies due to the escalating urbanization, particularly the urban expansion in peri-urban regions. This research seeks to identify the primary contributors to the growing vulnerability of static water bodies. The technique comprises a comprehensive and methodical examination of relevant literature, such as research articles, that analyses the urbanization scenarios of India's peri-urban areas and the features required to assess the quality and vulnerability of static water bodies. These static water bodies, in the shape of lakes and ponds, tend to be depleted by abrupt changes in Land use, the metalling of open surfaces, the disposal of solid waste, and an excessive rate of evaporation. These static water bodies in fragile peri-urban settings might be saved with comprehensive planning incorporating the right tactics and actions of local people and expert planners.

Keywords: Water Quality of lakes, Water quality Index, Static Water Bodies assessment, Vulnerability Assessment of Surface Water Body, Water Resource Management, Water quality in peri-urban areas, Critical threats to surface water bodies.

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INTRODUCTION

Ponds, lakes, and reservoirs play a crucial role in the ecological and socioeconomic fabric of India's peri-urban areas. However, these water bodies are increasingly susceptible to a variety of threats that endanger their viability and the welfare of neighbouring communities. This in-depth study focuses on the key vulnerable factors that influence static water bodies in India's peri-urban areas, shedding light on the particular challenges encountered and examining potential mitigation strategies [1]. The primary purpose of the study was to examine the threat posed to static water bodies by urbanizations, the leading cause of their depletion and pollution [2]. The Sustainable Development Goals (SDG) 6 - Clean Water and Sanitation for all - and SDG 11 - Sustainable cities and communities - stand out in terms of their relevance to urbanization and water security as Eco-sensitive and environmental protection threat objectives. As of the 1901 census, 11.4% of India's population resided in urban areas. This proportion increased to 28.53 percent by the 2001 census and is currently 34 percent, according to The World Bank. The United Nations projects that by the year 2030, 40.76% of India's population will reside in urban areas [3]. The United Nations predicts that by 2050, 68% of the world's population will reside in urban areas. Due to urban sprawl, pollution, and environmental degradation, unplanned or inadequately managed urban expansion, coupled with unsustainable production and consumption patterns and a lack of capacity among public institutions to manage urbanization, can compromise sustainability[4].

This urban expansion is primarily due to three factors: natural increase, rural-urban migration, and the expansion of cities, which has led to the annexation and transformation of rural areas into urban settlements [5]. Rapid changes in land use, biophysical environment degradation, social and economic differentiation, and increased pressure on natural resources are some of the effects of urbanization on peri-urban areas[6]. Urbanization processes are responsible for the shift from agricultural to urban, industrial, and recreational uses of water[7]. Other indicators of peri-urban water insecurity include rural-urban water flows to quench urban thirst, the acquisition of common property water resources to facilitate urban expansion, and the discharge of urban waste into rural water bodies[8]. Due to rapid urbanization and expanding human activity, peri-urban ecosystems are more vulnerable to degrading and becoming extinct [9]. Natural resources such as agriculture, horticulture, animal husbandry, forestry, and fishing are essential to the subsistence of the peri-urban poor in developing countries, according to a United Nations study[10]. Increasing water transfer from peri-urban to inner-city areas has decreased the availability of domestic and agricultural water in peri-urban areas[11]. The unequal distribution of natural resources has increased the burden on the poor and marginalized, who depend heavily on these resources for subsistence[12]. The entire equation of inner-city water demand and supply has increased pressure and competition for peri-urban water resources[13]. There are numerous interpretations of the term "vulnerability" among researchers.

In the context of water resources, vulnerability is defined as "the characteristics of water resources system weaknesses and flaws that make it challenging for the system to function in the face of socioeconomic and environmental change[14].The volume of water in a lake or pond remains constant throughout the year. Historically, these bodies of water were maintained by local communities[15]. Transferring maintenance responsibilities from the local community to government agencies increased the risk of encroachment and mistreatment[16]. Urban and peri-urban regions are experiencing a rise in encroachment. The increase in urban population necessitates the need for more land for housing and other infrastructure[17]. Last but not least, the limited and expensive land resources strain the water bodies[18]. Even for government agencies, water bodies are a convenient source of additional land for development. Existing urban and peri-urban water bodies must be preserved and rehabilitated in this scenario[19] . In South Asia, peri-urban water security concerns have received increased attention in recent years[20]. The PUI (Peri-Urban Interface) is a "attention-seeking" space, according to[21]. It is a site of both development and the problems that accompany it[22]. Recent trends indicate that while economic growth has stalled in metropolitan areas, manufacturing and service industries have shifted to PUIs[23]. Economic activity and employment relocation to the periphery[24]. Lakes have historically provided drinking water, water for household uses such as washing, water for agriculture, fishing, and water for religious and cultural purposes[25]. Lakes are also known to recharge groundwater, channel water flow to prevent water logging and flooding, and store water for future use. Lakes are

home to an abundance of plant and animal species[26]. The capital of Uttar Pradesh has lost 46% of its water bodies as a result of rapid urbanization altering its skyline. In addition, the majority are polluted with garbage and sewage [27]. The state government and the Supreme Court have taken numerous measures to prevent land grabbing and construction over water bodies, but the situation continues to spiral out of control[28]. The Lucknow Municipal Corporation conducted a survey in 1952 that revealed the city had 964 ponds. In 2006, the number decreased to 494[29].

METHODS AND MATERIALS

METHODOLOGY

Several literatures based on Assessment of static water bodies globally for different types of water bodies for different purposes has been selected and thoroughly reviewed. This literature is available on the web with keywords like, 'Water Quality of lakes', 'Water quality Index', 'Static Water Bodies assessment', 'Vulnerability Assessment of Surface Water Body', 'Water Resource Management', 'Water resource area', 'Surface Water Catchment Areas', 'Water quality in peri-urban areas', 'Critical threats to surface water bodies', etc in the form of Research papers, authenticated reports, and other forms such as books in order to comprehend the impact of urbanization, the nature of per-urban areas of India, and the vulnerability of static water bodies[30]. In addition, efforts have been made to identify the crucial factors that make these innocent static bodies susceptible to dangerous conditions, to the point where their very existence is being called into question. Multiple papers and reports assessing the vulnerability of static water bodies have been considered for this purpose. These aspects are then derived as parameters or factors responsible for the precarious state of static water bodies.

Impact of Urbanization on Static Water Bodies in India's Urban Periphery

The urbanization of static water bodies in India's peri-urban areas has had significant and mostly negative consequences not just on the natural environment, but also on the local inhabitants. Once-thriving wetlands, lakes, and ponds are eroding and disappearing as a result of urbanization[31]. Numerous plant and animal species are threatened by the delineation and preservation of catchment regions, feeder channels, and command areas of lakes, ponds, etc., which are destroying essential ecosystems[32]. This loss of biodiversity has an adverse effect not just on the delicate biological equilibrium, but also on the essential ecological services provided by these water bodies[33]. Urbanization also causes a decline in the quality of water in static bodies of water. Due to the discharge of untreated sewage, effluents from industrial activities, and municipal trash, water bodies are becoming progressively polluted[34]. The pollution in these bodies of water endangers not just the aquatic species that inhabits them, but also the human populations who depend on them for drinking water and other purposes[35]. In addition to degrading water quality, urbanization also generates hydrological changes in the regions immediately around cities[36].

The massive and rapid change in Land use of peri-urban zones caused by the construction of structures such as buildings, roads, and pavements prevent the natural penetration of precipitation into the ground, hence increasing surface runoff. Multiple small bodies of water in the city's peri-urban areas shrunk as a result of fast real estate development[37]. This alteration to the hydrological cycle increases peak flows during rainfall events, resulting in water loss through rapid runoff, excessive extraction of fresh water, and a decrease in the quantity of water returned to the land[38]. The impacts of urbanization are not restricted to environmental issues alone; they also have an impact on the means of subsistence of local communities[39]. Many peri-urban populations depend on static bodies of water for their livelihoods, such as fishing, agriculture, and animal husbandry. These traditional means of subsistence are threatened by urbanization and the deterioration of the water supplies on which they rely, which will ultimately result in a loss of income and food security[40]. In addition, rural-urban migration exacerbates the issue, and it is not uncommon for communities to be uprooted due to their dependence on these resources[41].Another result of urbanization is the formation of urban heat islands[42]. In order to convert static bodies of water into urban infrastructure, vegetation must be removed and heat-absorbing materials, such as asphalt and concrete, must be installed[43]. Consequently, the average temperature in neighbouring cities and towns is higher than that of the

surrounding rural areas. The urban heat island effect has deteriorated since static water features no longer have the same cooling impact as before[44]. A comprehensive and ecologically sound plan is required to counteract the negative impacts of urbanization on static water bodies in India's peri-urban zones[45]. Due to the low participation of urban planning and the residents' and authorities' understanding of static water sources, ignorance is fostered, resulting in unfavourable outcomes[46]. This plan must combine environmentally responsible urban growth, effective wastewater treatment, preservation of water bodies, and community participation[47]. Implementing methods such as rainwater collection, wastewater treatment, ecological restoration, and green infrastructure building can reduce the negative effects of urbanization on static water bodies and provide a more resilient and sustainable future for peri-urban regions[48]. These methods may also assist in mitigating the negative impacts of urbanization on flowing water bodies[49].

Assessment of Vulnerability in Static Water Bodies conducted by several authors
Several authors have assessed the vulnerability of static water bodies, highlighting the potential risks and difficulties these water bodies face as a result of a variety of factors[50]. Several of the vulnerability assessments conducted specifically in Indian scenarios are explained separately. Vulnerability Assessments performed by different authors on Static Water Bodies is summarized to gain a deeper understanding of the aspects of static water bodies that are vulnerable to transformation from their original form. "Assessment of Lakes of Vadodara City in terms of Water Quality Indices and their comparison". By analyzing land-use changes, encroachments, and pollution, this study analysed the vulnerability of Bangalore, India's tiny water bodies. The authors created a vulnerability index and determined the bodies of water with the highest vulnerability. Total nine variables are taken into consideration including water temperature, pH, dissolved oxygen, conductivity, turbidity, permanganate index, etc. The study highlighted the importance of including vulnerability assessments into urban planning procedures in order to guarantee the sustainable management of these water bodies[49]. " The changing water quality of lakes—a case study of Dal Lake, Kashmir Valley ". This report describes the recent changes in the water quality of Dal Lake. The report analyses the solutions that, if executed effectively, can be used to manage the lake and restore its quality.

Essential parameters like Water quality(temperature, pH, dissolved oxygen, conductivity, turbidity, permanganate index, etc.), biological diversity(bacterial pollution indicator species), Encroachment of the lakes(Harvesting and de weeding),Role played by the local community in lake management(Dredging of lake sediments, Public awareness program), Role of government departments(Solid wastes, sewage, and their management, Shoreline development,) have been taken into consideration[32]. " Water Quality Statue of Pushkar Lake After, During and Before the Pushkar Fair ". This research is based on the lake's water quality. Due to home and agricultural output, the mixing of storm and sewage water, and excessive congestion during the Pushkar fair, the Pushkar lake faces several challenges. In this, several Water Physic-chemical Parameters for water quality like pH, Temp Turbidity, Magnesium, Total Hardness, Nitrogen, Phosphorus, Potassium, Dissolved Oxygen., Biochemical Oxygen Demand, Chemical Oxygen Demand, etc and, Existing terrestrial flora & fauna. have been taken into consideration[47]. "Water Quality Assessment of Natural Lakes and its Importance: An Overview ".

This research provides an overview and critical analysis of the literature on all elements of water quality like Physical, Chemical, Biological in order to provide an understanding of the many instruments and strategies utilized for comprehensive monitoring and management of water quality[15]. "Assessment of Lake Water Quality by using Trophic State Index Indicators Parameters like Physical, Chemical, Biological for Ecological Lake Restoration- a Case Study of Bhimtal Lake, Kumoun Region, Uttarakhand, India". This study was conducted to incentivize Lake Water Quality in relation to the Eutrophication Status of Bhimtal Lakes and to develop a conservation plan for restoring Bhimtal Lake Water Quality[23]. "Applying The Social-Ecological System Framework to the Diagnosis of Urban Lake Commons in Bangalore, India": This study uses a social-ecological system (SES) paradigm to analyze why certain places have been successful in negotiating governance shifts from community-based systems to state control following urbanization, while other lakes have deteriorated. This followed the analysis of factors like Social, Economic, and Political Settings, Related Ecosystems, Resource Systems, Resource Units, Actors, Governance Systems, Interactions, Outcome criteria[43]. " Lake Vulnerability Assessment ": This study presented the LVRI (Lake

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Vulnerability Resilience Indicator) based on the vulnerability assessment of climate change which includes Exposure, Sensitivity, Adaptation Indicators for an environmental risk assessment in lakes suffering from water pollution from an integrated perspective of lake watershed features[13]. " Water Bodies Protection Index for Assessing the Sustainability Status of Lakes under the Influence of Urbanization: A Case Study of South Chennai, India,". This work employs indicators, a potent decision-making tool, and proposes the Water Bodies Protection Index (WBPI), which includes Water quality(Water quality variables—physical like pH, EC, TDS, DO, temperature, hardness, chloride, alkalinity, nutrients like phosphate, nitrate and BOD), biological diversity (Plankton diversity), water spread area(Original water spread area of lakes and the area encroached), role played by the local community in lake management (Level of awareness and participation toward protection of lakes), and role of government agencies(Available acts on lake protection, level of upkeep and preservation) are the five factors chosen for formulating the Water Bodies Protection Index. A monitoring and ranking tool that may be used to prioritize conservation efforts for peri urban water bodies[44].

" Strategic environmental assessment of Pushkar Lake, Ajmer (Rajasthan) with special reference to infiltration problem ". This study focuses on the Strategic Environmental Assessment (SEA) of Pushkar Lake which includes parameters like Physic-chemical parameter, Existing terrestrial flora & fauna within The 10 kmradius of project influenced area, Socioeconomic Characteristics of the affected area, paying special emphasis to the infiltration issue that has a detrimental effect on its religious significance[40]. " Dip in a sacred lake: Divinity or Devastation Case study of Pushkar lake during the Panch Teerth Maha Snaan": This report aims to offer information on the water contamination produced by humans during the Panch Teerth Maha Snaan in the holy lake of Pushkar by assessing physio-chemical properties[36]. " Studies On Physio-Chemical Characteristics of Dal Lake, Srinagar Kashmir ". The purpose of this study was to assess the existing physicochemical features of Dal Lake in Srinagar District, Kashmir.

From January to December 2011, monthly variations in physio-chemical parameters such as water temperature, clarity, pH, conductivity, dissolved oxygen, Free Co2, Alkalinity, chlorides, Ammoniacal nitrogen, Nitrate nitrogen, and Total phosphorus were examined[32]. " Assessment of Physio-Chemical Characteristics and Suggested Restoration Measures for Pushkar Lake, Ajmer Rajasthan (India)". This report aims to offer information on the water contamination produced by humans during the Panch Teerth Maha Snaan in the holy lake of Pushkar[47]. Similarly various organizations have also done vulnerability assessments on static water bodies which can be summarized as follows; School of Planning & Architecture, New Delhi under the Namami Gange Mission, India has done 'Urban Wetland/Water Bodies Management Guidelines January 2021 Volume I A Toolkit for Local Stakeholders', in 2021 which mainly includes the Assessment on Ecosystem Services in Urban Wetlands based on Factors like Assessment of Impact of Urban Development Trends on Wetlands/Water bodies is done based which broadly includes Indicators[3]. These studies and others like them provide valuable insights into the vulnerability of static water bodies in peri-urban areas. This information helps to raise awareness and guides policymakers, researchers, and stakeholders in the development of appropriate conservation, restoration, and sustainable management strategies.

RESULTS AND DISCUSSION

In essence, eight Vulnerability Factors for Static Water Bodies have been identified that are essential for comprehending the origins of susceptible situations in static water bodies. They are listed below:

Land Use and Population Density

1. Land use generates new water needs and claims, which gradually shift from agricultural to urban, industrial, and recreational uses.
2. The increase in nutrient runoff is one of the most severe consequences of land use change on lakes.
3. High population density can raise the demand on freshwater resources, leading to their overexploitation and depletion.
4. Aside from that, a rise in population density tends to lead to an increase in solid waste creation, which may result in the partial dumping of solid waste near static water bodies and the subsequent polluting of these bodies.

Encroachment

1. In peri-urban locations, the lake margins have been encroached upon either by residents establishing new villages or by "Real Estate" developers.
2. The drainage system that originally linked these lakes has been damaged, resulting in a decrease in the amount of rainwater that flows into these bodies of water.

Community Use

Clothes washing, animal bathing or animal wading, fishing, dairy production, discharge of industrial waste, etc. degrade water quality, destroy habitat, and endanger aquatic life.

Pollution

Pollution is a major issue in Peri-Urban zones where population growth has outpaced the expansion of municipal infrastructure, such as waste disposal and management facilities. (S. Siddiqui, 2018).

Community Participation

It is extremely challenging to strike a balance between ecological concerns and social justice while fostering collaboration among a wide number of stakeholders with drastically varying socioeconomic, cultural, and political perspectives. (Mundoli et al., 2015).

Mining Activities

Illegal mining, particularly of clay soil for the production of bricks or sand on the catchment and bed of water bodies, is another factor in the degradation of numerous water bodies.

Recreational /Tourism Activities:

Unregulated and unplanned recreational activities around water bodies have resulted in the persistent dumping of trash into neighbouring water bodies and the erosion of shorelines. This has a detrimental influence on the lake and its surroundings.

Institutional Role

1. Another difficulty with PUIs is the haziness of institutions' duties (Bentinck J., 2000)
2. In addition, the volume and scope of changes occurring at the local level in the PUI frequently exceed the capacity of local administration (Thuo, 2013; Mattingly M., 1999)

CONCLUSIONS

Maintaining static water bodies is important. environmental and eco-system maintenance. India's peri-urban ecology and economy depend on ponds, lakes, and reservoirs. Lakes have supplied water for drinking, washing, agriculture, fishing, and religious and cultural purposes. Lakes replenish groundwater, prevent water logging and flooding, and store water for future use. Lakes have many plant and animal species. These bodies of water are increasingly vulnerable to a variety of threats that threaten their viability and neighbouring communities. Urban sprawl, pollution, and environmental degradation can result from unplanned or poorly managed urban expansion, unsustainable production and consumption patterns, and a lack of public sector capacity to manage urbanization. Natural increase, rural-urban migration, and city growth have caused the annexation and urbanization of rural areas. Urbanization in peri-urban areas causes rapid land use changes, biophysical environment degradation, social and economic differentiation, and natural resource pressure. Urban and peri-urban encroachment is rising. Urbanization requires more land for housing and infrastructure. Finally, expensive and scarce land resources strain water bodies. Government agencies can easily develop water bodies. This scenario requires preserving and rehabilitating urban and peri-urban water bodies. Urbanization of static water bodies in India's peri-urban areas has had major negative impacts on the environment and local residents. Urbanization is eroding wetlands, lakes, and ponds. Delineating and preserving catchment regions, feeder channels, and command areas of lakes, ponds, etc., which destroy vital ecosystems, endanger many plant and animal species. The delicate biological balance and vital ecological services provided by these water bodies are affected by this biodiversity loss. Urbanization degrades static water quality. Sewage, industrial effluents, and municipal waste pollute waterways. These bodies of water are polluted, endangering aquatic life and the people who drink their water. Urbanization alters local hydrology and water

quality. The rapid construction of buildings, roads, and pavements in peri-urban areas prevents precipitation from percolating into the ground, increasing surface runoff. Numerous city's peri-urban small bodies of water shrank due to rapid real estate development. In peri-urban areas, the crucial aspects that were derived from analysis provide valuable insights into the vulnerability of static water bodies. This information contributes to the raising of awareness and directs researchers, policymakers, and other stakeholders in the process of developing appropriate conservation, restoration, and sustainable management strategies. It is absolutely necessary to devise and put into action comprehensive plans for the preservation and administration of static water bodies in the peri-urban areas of India. The plans ought to put an emphasis on environmentally friendly urban planning, enhanced procedures for waste management, stringent compliance with regulations, and active participation from the community. In addition, it is essential to address the underlying causes, such as urbanisation and climate change, in order to ensure the long-term health of static water bodies in peri-urban areas and their ability to persist for future generations and thus actually try to achieve SDG goals, especially SDG-6 and SDG-11.

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RESEARCH ARTICLE

Security Issues in Mobile Wallets: A User Perception Study at Bangalore Rural District.

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ABSTRACT

The globalised world is dominated by technology and innovation because the present generation is more tech-savvy, electronic devices specially internet enabled smart phones have become an important part of their lives. The mobile wallet sector in India has benefited from the rapid usage of smart phones and mobile internet. Mobile wallets are used for most the payments by the people which is a building block of their lives because M-wallets provide many cybernetic services ranging from utility to e-commerce activities. This study is to examine the user's perception towards the security issues of m-wallets in Bangalore rural district in the fast-paced technology era. A total of 372 respondents' responses were collected and analysed using a structured questionnaire method and found that users are still finding security issues. This study will aid smart phone manufacturers, M-wallet service providers, regulatory agencies and financial institutions to prevent security concerns through appropriate design to convince their consumers about the security of their m-wallets.

Keywords: mobile wallets, personal information, security, safety

INTRODUCTION

India's mobile wallet market has experienced growth as a result of the COVID-19 pandemic. There is a lot of room for mobile wallet adoption in this nation due to its restricted mobility and heavy reliance on banks. A lot of the previously unreceptive citizens started using mobile wallets during the outbreak. Because of the market's heavy reliance on e-commerce platforms, it experienced a notable uptick during COVID-19. Although security has emerged as a major barrier to mobile payment acceptance, the security issues in adoption of m-wallets has been not much

explored particularly from the perspective of customers. As a result, this research aims to take an empirical approach to the problem in order to gain a deeper grasp of the notion.

Significance of the Study

Mobile payments have increased as a result of the cash crisis brought on by demonetisation and COVID-19, according to reports from the Reserve Bank of India and the Indian government. Because smartphones and internet are so inexpensive, most daily payments are done through mobile devices. In India, the amount of digital payments made during the fiscal year 2021–2022 climbed by 33% year over year. The use of m-wallets has increased dramatically over time, with a total of 7,422 crore digital payment transactions reported during this period (up from 5,554 crore transactions seen in FY 2020–21, according to Ministry of Electronics and IT data). Therefore, it's critical to investigate the security concerns with m-wallet, including lost or stolen money or devices, phishing schemes,

REVIEW OF LITERATURE

Alqahtani, M. S. A., & Erfani, E. (2023) The development and implementation of security actions and controls are crucial steps in protecting an organization from external threats. Unfortunately, most of the effort toward improving cyber security is concentrated on implementing new technology solutions. This paper aims to provide policymakers and technology experts with a comprehensive understanding of the multiple factors that affect a company' cyber security compliance, as well as the steps involved in implementing effective measures. The article also explores the factors that influence cyber security. It uses the UTAUT2 model to study the relationship between technology acceptance and use. Chawla, D., & Joshi, H. (2023) This study aims to identify the various types of user segments and their maturity levels. It then constructs a model that explains how these segments view their adoption and how these constructs can influence their attitudes. It also aims to analyze the effectiveness of these constructs and identify areas where they can improve. The TAM and the UTAUT are two theories that talk about how people embrace new technology. A pilot instrument was then created using the synthesized literature review. The discussions were conducted in two focus groups. The study revealed that mobile wallet providers need to focus on the six components of their product, with SEC, LC, PU, and SEC getting the most attention.

Mew, J., & Millan, E. (2022) The services that a mobile wallet provides must be reliable, trustworthy, and always available. Issues related to its use can have an impact on the satisfaction of consumers and the value they perceive from their service providers. This study looks into the various factors that can prevent or influence the use of such technology. The study utilizes a mixed-method approach to gain a deeper understanding of the phenomena being examined. The conclusions are thus solidly based on empirical data. The conceptual model combines old and new ideas derived from the study participants' actual experiences. The results support the significance of each component taken into account in the model, as they all had indirect or direct impact on consumers' intention to adopt and use the mobile wallet and contributed significantly to its variance. BalKrishnan & Shuib (2022) The study investigated the connection between Malaysians' usage of cashless applications and their readiness for a cashless society. Specifically, a model Cashless Society Readiness-Adoption has been developed to examine driving factors in order to evaluate their direct and indirect effects. UTAUT 2 and the Technological Readiness Index 2.0 served as the foundation for the model's development. The outcomes would be advantageous to the relevant stakeholders, including service providers, financial institutions, and governmental organizations, in developing and designing strategies to effectively encourage more individuals to adopt digital payment systems.

Shobha, B. G. (2021) in their research tried to understand the "awareness" and "preferences" for using M Wallet in Bangalore's Rural Area. Using the non-probability Judgmental sampling method, 200 samples were selected. The data collected using structured questions on a Likert five-point scale. The findings showed that the favored e-wallets, such as Google Pay, Pay TM, and Phone Pe, had a moderate level of awareness. Another area of worry that the cyber law must treat carefully in order to safeguard M-Wallet users' interests is cybersecurity. Alam, M. M., et al., (2021) this research work intends to examine the difficulties and opportunities associated with using electronic wallets in

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Malaysia, as well as how it helps for consumers and businesses. Gave some ideas for how to take advantage of your assets and opportunities while fending off dangers and shortcomings. Here are some ideas for how to take advantage of your assets and opportunities while fending off dangers and shortcomings. To evaluate Malaysian company development and to evaluate the e-wallet portent utilizing a SWOT analysis. Findings from the literature and secondary data are used to support it. The World Bank and Bank Negara Malaysia provided the pertinent secondary data. This study demonstrates that although there is great potential for e-wallets in Malaysia to succeed, they have not yet done so. The SWOT analysis revealed a number of strengths (such as financial incorporation, ease of access, protection and safety, protection and safety for other accounts, management of products and consumer services, and quick implementation/administration), weaknesses and opportunities

Daragmeh, A., *et al.,* (2021) Evaluated how The World Health Organization and other organizations urged people to use contactless payment systems rather than cash, which has the potential to spread the SARS-2 infection. The core objective of is to assess the factors which influence Generation X's in utilizing mobile m-payment services in Hungary during covid. We surveyed 1120 members of Generation X using an electronic questionnaire. Their findings endorse that perceived risk of COVID-19, usefulness, and subjective norms strongly influence Gen- X behavioral intents to utilize the services of m-payment system. Used SEM to examine the conceptual model developed for the study. Moreover, perceived usefulness worked as mediator between perceived usability and propensity to adopt system of m-payments. George, A., & Sunny, P. (2021) M-wallet service providers and researchers are investigating the adoption of mobile wallets and their continuous use, due to COVID-19, greater reliance on them, and the public's acceptance of them as well as other related e-services. Using a variety of technological adoption models and behavioral research, this study theoretically investigates aspects affecting users' actual usage of mobile wallets and behavioral intention. This research seeks to develop a thorough conception of m-payments uptake and real usage by examining the impact of many important elements based on proper literature review. The usage of mobile payment system might be successfully illustrated by the presented model, and it also provides the opportunity to draw significant managerial conclusions about efficient marketing strategies.

Lu, W., *et al*., (2021) this research evaluated the opinion of QR code mobile payment system adopters regarding continuous usage intention. The sample size of this empirical research was 215 mobile payment users. The variables considered in this study were chosen from UTAUT model. Two more factors were added to the model as moderating factors which were all the factors has significance on Unceasing use of QR code payments. Usefulness was the important influencing factor. risk had no effect on continuance usage intention. Other side Involvement had a positive and moderating effect on PE, EE on incessant usage intention. But involvement was a negative moderator between Social Influence and continuous usage intent. It was concluded that traditional payment method was too time consuming, so Chinese population were getting shifted from regular payment method to m-payment method. The study suggested m- payment system service providers to concentrate more on fast completion of transactions. Grover, P., & Kar, A. K. (2020) this research analyses how mobile wallet firms are using social media platform to promote their services and interact with their customers. It looks into the various promotional and acquisition activities that they are doing on Twitter. The study analyzed "Free-charge", "Oxigen Wallet", and India's MobiKwik. The study also proposed a social media engagement framework to study the dynamics of the service utilisers. The study suggested that mobile wallet firms should promote their services through various content types, such as entertainment, social, and informational. They should also regularly campaign to increase their network size. The outcomes of this research help wallet companies to plan effective social media campaigns.

Statement of the Problem

Technically speaking, a mobile wallet is a free download available through the smartphone play store. Various manufacturers offer a variety of m-wallets for download on the market. Since everyone has an internet-connected smartphone these days, m-wallets are a great choice for a variety of daily payments. The number of m-wallet transactions increased as a result of the central government's digital awareness campaign and demonetisation (annual report of RBI-2021). However, security concerns—such as those pertaining to confidentiality, authentication,

integrity, authorization, and non-repudiation—were the primary deterrents to m-wallet adoption (Dhingra. et al., 2020). This study aims to address these concerns at the rural district of Bangalore.

Objectives of the Study
To evaluate the demographic profile of the m-wallet users
To examine security issues faced by the m-wallet users.

METHODOLOGY OF THE RESEARCH

This empirical study is descriptive and analytical in nature, the study's primary source of data extracted from 372 m-wallet users (convenient sampling) of Bangalore rural district using five point Likert scale questionnaire and analysed, and respondents are of different gender, age, income, level of education, and place of residence. The statistical tools used in the analysis such as percentage analysis and cross tabulation for the interpretation of the data.

Data Analysis and Interpretation
This study distinguished between the two characteristics of objective and subjective security in order to focus on the crucial prerequisite of "security," which is crucial for customers to accept a mobile payment process. Similar to permission, confidentiality, authentication, integrity, and non-repudiation, objective security is a technical attribute (Merz 2002). The degree of subjective security, or "what would they require to feel secure about using m-wallets," is influenced by the objective security level, not the other way around. Data was gathered and examined using the objectivity-influenced subjectivity questions that followed. The above table is constructed to understand whether the demographic factors are influencing on adoption of m-wallets or not. Understood from the table that maximum m-wallet users are between 31 to 50 years of age category and middle age people are using more than any other age category users. Very importantly maximum users are male. Lower income group people are using the m-wallets most and their education qualification is Graduation. From the study it is understood that semi urban (taluk level) people are using more. It is understood from the available data that many users are using maximum three wallets and data also shows around 41 percent using maximum 5 different wallets and maximum users are using wallets for maximum 25 times in a month. The above table is constructed to understand the users' response about the safety of their personal data in m-wallets and found that majority users' opinion is, personal and banking details are not safe in the m-wallets and only 17 percent of the users said that the data of the users is safe whereas 50 percent of the respondents said not safe. From the analysis, overall 48 percent of the users opinion is unauthorised people cannot access to their m-wallets but 42 percent of the users says yes, unauthorised access possible to wallet. In order to understand user's awareness about data safety from service providers this table was constructed and observed there is almost mixed opinion about whether users personal information is exposed to third party or not. 56 percent of the respondents said their personal information is exposed to third party whereas 44 percent said not. From the study, it can be interpreted that, transactions failure in m-wallet are quite common and 99 percent of the users are with the same response. The data from the table says, 52 percent of the respondents are not getting immediate refund when transaction is failed amount is deducted, it is not that easy and quick of getting refund immediately but 45 percent of the respondents said yes it is easy and there is a communication about failed transactions. It can be concluded from the table; 50 percent of the respondents are getting confirmation about their payments whereas around 26 percent of the respondents are not getting any confirmation immediately after their transactions. Users perception about hacking of their wallets is, 50 percent of the users said hacking and cybercrimes are possible and only 30 percent of the respondents said it is not that easy. There is a mixed opinion about safety, security and reliability of the m-wallets in rural Bangalore, 49 percent of the respondents' opinion is, m-wallets are not safe whereas 51 percent of the respondents said m-wallets are safe.

Major findings of the study

1. From the study found that maximum m-wallet users are between 31 to 50 years of age category and middle age people are using more than any other age category users.
2. Very importantly maximum users are male. Lower income group people are using the m-wallets most and their education qualification is Graduation.
3. From the study it is found that semi urban (taluk level) people are using more.
4. Found that users are using maximum three wallets and data also shows around 41 percent using maximum 5 different wallets and maximum users are using wallets for maximum 25 times in a month.
5. Majority respondent's opinion is that, personal and banking details are not safe in the m-wallets which is a major factor may be influencing negatively on adoption of m-wallets for daily payments in Bangalore rural district.
6. Found from the study that unauthorized people cannot access to their m-wallets so easily unless user's negligence.
7. It is observed, there is a mixed opinion about whether respondent's personal information is exposed to third party or not. 56 percent of the respondents said their personal information is exposed to third party whereas 44 percent said not.
8. It is found that, transaction failures are quite common during peak hours and 99 percent of the respondents agreed for the same.
9. From the research found that users are not getting immediate refund when transaction is failed and amount is deducted because it is taking 24 hours to 48 hours for refund of deducted money. Due to this they face shortage of funds in emergency time.
10. It is found from the oral discussion with users, if the attached bank account belongs to public sector, sometimes there is no proper communication of transactions/ payments in their Bank account through SMS or mail.
11. Found evidently that hacking and cybercrimes are possible, which is stopping rural people adoption of m-wallets and only 30% of the respondents said it is not that easy
12. Over all 51% of the users said m-wallets are safe which is a positive side but 49% of respondents still feeling not safe about m-wallets

IMPLICATIONS AND CONCLUSIONS

Examining m-wallet security concerns was the goal of this study. The findings of this descriptive study indicate that middle-aged individuals are more likely than those in other age groups to embrace m-wallets. As a result, it is recommended that service providers and regulatory bodies introduce new, more user-friendly technologies to boost adoption rates in rural areas. It is recommended that service providers employ live demonstrations, digital literacy programs, or other promotional activities to raise awareness among rural customers about the benefits of m-wallet usage. It is recommended that service providers and device manufacturers enhance security features and promptly resolve grievances. Therefore, increasing adoption in rural areas and fostering user confidence are both viable. Once more, it is recommended that service providers standardize the wallets' performance, security measures, authorization, and downloading and installation processes. The conclusion is that, there are security concerns in adopting and using m-wallets, some concerns are real in practice but some concerns are misunderstood because rural people are with lack of knowledge and technological education. If policy makers, financial institutions, m-wallet service providers and smart phone manufacturers come together it is possible to overcome the security issues in m-wallets, in turn misunderstandings about m-wallets can be detached.

Limitations and Directions for Future Research
Time and financial restrictions forced this study to limit its sample size to 372 rural district residents of Bangalore. Because of timely changes, research focused on consumer behavior cannot provide results that are long-lasting. More

respondents, a comparison between urban and rural areas, districts, states, corporations and non-corporate entities, and the entire nation could all be included in an extension of this research.

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Table-1: Demographic factors analysis

Variables	Category.	No. of respondents.	Total percentage.
Age category	Up to 30	119	32
	31-50	160	43
	51 and above	93	25
Gender	Male	212	57
	Female	160	43
Monthly Income per month	Up to 25000	160	43
	25001 to 50000	145	39
	50001 and above	67	18
Educational qualifications	10 +2	149	40
	Graduation	167	45
	Post-graduation and Above	56	15
Locality	Rural/ Hobli HQ	145	39
	TMC	153	41
	CMC	74	20

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How many wallets you are using	1-3	171	46
	3-5	153	41
	More than 5	48	13
Frequency of use per month	0-25	201	54
	25-50	108	29
	more than 50	63	17

Table-2: My personal and banking details are safe in m-wallets.

Categories	Respondents	% on 372 respondents
Strongly Disagree.	67	18
Disagree.	119	32
Neutral.	15	4
Agree.	108	29
Strongly agree.	63	17
Total	**372**	**100**

Sources- Primary Data

Table-3: Unauthorised access of my m-wallet is not possible because Password is not visible to anyone.

Categories	Respondents	% on 372 respondents
Strongly Disagree.	56	15
Disagree.	100	27
Neutral.	37	10
Agree.	93	25
Strongly agree.	86	23
Total	**372**	**100**

Sources- Primary Data

Table-4: I believe my personal information is not exposed to third party by m-wallet service providers.

Categories	Respondents	% on 372 respondents
Strongly Disagree.	119	32
Disagree.	89	24
Neutral.	00	00
Agree.	71	19
Strongly agree.	93	25
Total	**372**	**100**

Sources- Primary Data

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Table-5: There is no transaction failure in m-wallets

Categories	Respondents	% on 372 respondents
Strongly Disagree.	219	59
Disagree.	149	40
Neutral.	4	01
Agree.	00	00
Strongly agree.	00	00
Total	372	100
Sources- Primary Data		

Table-6: In case of transaction failure if the money is deducted, getting refund of deducted money is easy, quick and there is a communication for the same.

Categories	Respondents	% on 372 respondents
Strongly Disagree.	107	29
Disagree.	85	23
Neutral.	11	3
Agree.	99	27
Strongly agree.	70	18
Total	372	100
Sources- Primary Data		

Table-7: Am getting confirmation of payment after every transaction

Categories	Respondents	% on 372 respondents
Strongly Disagree.	30	8
Disagree.	67	18
Neutral.	89	24
Agree.	112	30
Strongly agree.	74	20
Total	372	100

Sources- Primary Data

Table-8: Hacking and cybercrimes are not possible in m-wallets

Categories	Respondents	% on 372 respondents
Strongly Disagree.	67	18
Disagree.	119	32
Neutral.	37	10
Agree.	97	26
Strongly agree.	52	14
Total	372	100

Sources- Primary Data

Table-9: Overall I feel m-wallet is safe, secure and reliable for financial transactions

Categories	Respondents	% on 372 respondents
Strongly Disagree.	93	25
Disagree.	89	24
Neutral.	00	00

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Agree.	**108**	**29**
Strongly agree.	**82**	**22**
Total	**372**	**100**
Sources- Primary Data		

RESEARCH ARTICLE

Awareness and Challenges of Digital Inclusion for Micro and Small Entrepreneurs in Rural Bangalore

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ABSTRACT

Digitalization, as a concept is not restricted to urban areas but also has been making inroads into rural India and holds the prospect. It has a growing impact on micro and small-scale businesses. The advanced technology and internet accessibility has paved way for the adoption of digital operations in rural areas. This paper aims to find out the awareness and accessibility of digital adoption by micro and small entrepreneurs in their business. It also identifies the challenges faced by them in digitalisation of their businesses. The study uses the sample of 150 entrepreneurs from micro and small enterprises across Bangalore rural areas. The study tries to test the hypothesis by using regression and correlation techniques. This paper also recommends them the ways and means for the improvement of digitalisation of their business.

Key words: Digitalisation, Micro, small entrepreneurs, rural areas

INTRODUCTION

Technological revolution makes the human life very easy and simple. The rapid growth of technology has influenced the global activities and transformed the economic, social and political environment. At the same time the business world also has influenced by ICT application, which helps for the business expansions. With the help of ITC the

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business digitalises' its all activities and it creates opportunities and threats to the small business. The small business like micro and small enterprises take this digital inclusion as a challenge and compete with its competitors.

Digital Inclusion

Digital inclusion is the individuals and groups of people capability to access and use the information and communication technology (ICT) in various business situations on par with the technological transformations. As digital inclusion is not just about computers or the Internet, but it is the usage online and mobile technologies as channels to improve skills, to enhance quality of life, to drive education and to promote economic wellbeing across all elements of society (Australian Digital Inclusion Index, 2015). In addition, digital inclusion enables the various clusters of society, businesses and educational institutions to have access to technology which helps them to use and analyse its current information. The fast internet access enables the digital inclusion to access the information physically. Thus, it provides a bigger opportunity for economic growth with the usage of ICT and also to enhance the relationship with the support systems. (Faradillah Iqmar Omar, Ali Salman & Samsudin A.Rahim, 2015).

The usage of internet and the technological applications in the business is inevitable for the entrepreneurship. In this techno flexi business environment, their survival of the business is based on their digitalisation process and its application in business. Digital inclusion is essential for their business processes as it helps to overcome the cut throat competition by adopting cost-effective marketing techniques and expansion of the potential customers.
 According to Asian Development Bank (ADB, 2014), the small and medium-sized enterprises (SMEs) are the backbone of Asian economies and they are very important for contributing to economic development of the country. As the SMEs helping the multinational corporations by suppling its supplementary for the main products, they should be aware about the digital inclusion for dealing with the multinational companies to deliver its operations in a quick mode.

LITERATURE REVIEW

K. Suma Vally and K. Hema Divya examines the impact of adopting digital payments effects on users of banking in India. The report of their study tells us how to increase cashless payment in the country. The result specifies that the adoption of technology for digital payments improves the performance of banking sector. Also it said that banks should take effective measures to create awareness to the customer about the effective utilization of technology and security. Sudiksha Shree, Bhanu Pratap, Rajas Saroy and Sarat Dhal in their research governments, regulators & service-providers are working to improve the e-payment system. Researchers recommended that perception of digital of digital payment tools affects the payment behavior of an individual. Dr.R.KrishnaKumari, Ms.G.Pavithra said through their research said that 24*7 service, time saving, convenience and security helps to strengthen the digital payment system. It helps in cost reduction and simplifies the process of e-payment process. Public is facing fewer problem to use cashless method at present.

Dr. D. S. Borkar, Mr. Avinash Galande cleared that digital payment system is growing faster. There are lot of opportunity in India for digital payment business. Now a days due to the Government initiative in India and banks initiative to provide the awareness among the customer still proper education is required to the customer banks. Presently it has been observed that there is high cost of infrastructure and lack of financial literacy among the people. E-payment system helps the people to maintain the transparency and also helps to security. Dhruvi Bhagat said that pandemic 2020 has impacted the digital payment system and also a game changer for India for digital payments adoption ever since the demonetization in 2016. Author suggests that retail stores must adopt and influence the customer to use the E-payment transaction.

Statement of the Problem

In the current scenario internet place, a major role for the day today activities. The use of internet, digital technology such e transaction, data storage and other business activities are accepted and practices by both entrepreneurs and customers. It will increase the purchasing power of the consumers. In our country there are so many unorganized

sectors, which are mostly live in the poor economic conditions. Micro and Small-Scale Enterprises not only contribute significantly to improved living standards, they also bring about substantial local capital formation and achieve high levels of productivity and capability. Digital inclusion would influence the internal business processes of an organization as well its functions of Indian market. It has its influences to SMEs on their restricting of the infrastructure and resources, in terms of information technology systems, value chain, pricing and others[3]. In Bengaluru north, rural areas many SMEs are contributing more for the economy through their business. In this situation this study takes the initiation to analyze the opinion of entrepreneurs, in SMEs as they are one of the major players in the economic development of any industrial areas like rural areas in Bangalore North.

RESEARCH METHODOLOGY

The research design adopted in this study was a blend of analytical and descriptive in nature. Population of this study has comprised Micro and Small Enterprises (SMEs) under rural areas such as vijipura, Nelamangala, Hosakote, Chikabalapura, Dodabalapura and Kanakapura in North Bengaluru. Convenient sampling method was used to collect the data. In this method 150 registered Enterprises were taken for data collection. With the help of literature review, questions were framed on awareness and the opinion of digital inclusion in SMEs. And the responses to these questions were collected using interview schedule questionnaire method. Data were analyzed by using statistical tools such as frequency, percentage and one way ANOVA.

Objectives:
1. To study the awareness and challenges about the digital inclusion in MSMEs
2. To find the opinion about the digital inclusion among the entrepreneurs of MSMEs
3. To suggest the ways and means for the entrepreneurs about the digital inclusion

Analysis and Interpretation:
This study analyses the awareness about digital inclusion among the entrepreneurs, and the results were as followed in Table 1.

From the above Table 1, the respondents were getting highest awareness about digital inclusion from their friends and relatives. They motivate and due to their pressure others also follow the same.
Digital inclusion also such one such the second highest source is their business circle. If one businessman aware about any business techniques it will be followed by others also.
This study analysis opinion about the digital inclusion among the entrepreneur

In the above Table 2, it was found that 'p' value (level of significance) was less than 0.05 at 1 degrees of freedom. So the hypothesis was rejected for organization and the study proved that the opinion of digital inclusion among the types of organization were differing. In the micro enterprises the entrepreneurs were still in the process of the digital inclusion. Slowly they are transforming to digital inclusion. Among the male and female entrepreneurs, and married and unmarried entrepreneurs, the opinion about digital inclusion are same. The study accepts the null hypothesis for both gender and marital status of the entrepreneurs about their opinion on digital This study analysis the opinion of SMEs that the digital inclusion is benefited for the organization. The study marked their opinion and analysed as followed

In the above Table 3, it was found that 'p' value (level of significance) for income, education, age and trading period was more than 0.05 at 4,5,2 and 3 degrees of freedom. So, the hypothesis was accepted for income, education, age and trading period. The entrepreneurs having same opinion about digital inclusion for their business in spite of their age, income and education. The entrepreneurs have to accept the digital inclusion and if they deviate from the digital inclusion they will away from their business.

FINDINGS

The study has following Findings
- Friends and relatives (37%) and business circle (33%) motivates the entrepreneurs for their digital inclusion.
- The process of digital inclusion, the micro enterprises are slowly transforming their business into the digital inclusion. Most of the small enterprises are already in the process.
- The opinion about the digital inclusion for the business is accepted by both gender and the married and unmarried entrepreneurs.
- The study has found that the entrepreneurs are having the same kind of opinion about digital inclusion, that without that the business cannot move forward.

Suggestion
The government have to encourage the digital inclusion of SMEs by
- To remove the gap of technology adoption by providing SMEs with technology support and assistance.
- To involve more SMEs to adopt digitalisation by encouraging SMEs training and upskilling in the digital technology.
- To give more protection to SMEs by raising the digital security profile of SMEs.
- To access the strategic resources for the digital inclusion easily to SMEs by leveraging fintech and financial assistance

CONCLUSION

Digital transformation is an ongoing process that is constantly evolving and business enterprises that embrace digital transformation will be better positioned to compete in the future and deliver value to their customers. The SME entrepreneurs need to think quickly and adapt the changes in a dynamic way. The companies to achieve success should keep a step ahead in utilizing the opportunities arising out of the changes in the information and technology.

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Table 1. Awareness about Digital Inclusion

Sl No	Sources	No of Respondent	Percentage
1	Social media	34	23
2	Friends and relatives	55	37
3	Magazine and newspaper	7	04
4	Telephone/ radio	5	03
5	Business circle	49	33

Table 2 One Sample T Test for Digital Inclusion and Entrepreneurship

particular	Type of Organisation	N	Mean	S.D	Mean Diff	't' value	Sig.
Gender	Male	116	2.23	0.44	148	1.159	0.248
	Female	34	2.13	0.35	65.602		
Marital Status	Married	126	2.212	.4361	147	0.427	0.670
	Un married	24	2.171	.3484	35.865		
Orgainsation	Micro	90	2.122	.3716	148	-2.898	0.003
	Small	60	2.329	.4632	107.394		

Table 3 Opinion about the Digital Inclusion Among the SMEs.

Particular	Types	N	Mean	S. D	Source of Variance	Mean Square	'F'	Sig.
Income	Less than 200	1	1.765	-.	Between Groups	.341	1.970	.102
	201-500	29	2.304	.3305				
	501-700	29	2.318	.4498	Within Groups	.173		
	701-1000	34	2.196	.2727				
	Above 1000	57	2.110	.4991				
Education	Uneducated	4	2.103	.2897	Between Groups	.223	1.269	.275
	Primary	4	2.103	.2371				
	Middle	8	2.463	.5074	Within Groups	.176		
	SSLC	20	2.094	.3002				
	PUC	35	2.286	.5148				
	Graduation	60	2.153	.4096				
	Any Other	28	3.987	.7804				
Age	Below 25	14	2.193	.2839	Between Groups	.003	.018	.982
	26 to 40	99	2.210	.4479				
	Above 40	37	2.197	.4007	Within Groups	.003		
Trading Period (in years)	Less than 5	41	2.176	.3190	Between Groups	.355	2.055	.090
	6 to 10	57	2.243	.4165				
	11 to 15	31	2.106	.5054	Within Groups	0.173		
	More than 15	19	2.368	.4488				

REVIEW ARTICLE

Effectiveness of Compliance Training on Occupational Fraud Prevention with Special Reference to Multi-National Companies

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ABSTRACT

Over the years Multi-national Companies have been training their employees to be complaint with various laws and regulations mandated by the governing bodies. The training focusing on Code of Conduct, Privacy and Data Protection, Anti-money laundry, Anti-Fraud, Cyber Security, Profession/Role Specific statutory Training etc.., non-complaint to statutory mandated training will result in MNCs face hefty penalties, loss of license, loss of reputation, most importantly the purpose of the training to educate their employees on dos and don'ts which could harm their business. Irrespective of governing bodies and companies provide training, still the occupational discipline is lacking among some workforce which are witness over multiple corporate fraud cases. As a result of lack of occupational ethics, companies are exposed to fraud and suffer financial and non-financial loss, which raises significant question on the effectiveness of Compliance Training. This study is aiming to study the effectiveness of the compliance training provided to its employees by the multinational companies.

Keywords: Compliance, Training, Multinational Companies, Occupational Fraud, Corporate Frauds.
JEL CODE: M53, M42

INTRODUCTION

Fraud is a criminal act that is indents to deceive someone for financial and personal gain. Occupational fraud is one such fraudwhere employee of an organization deceives their organization for financial and personal gain, occupational fraud can be of internal (employee, managers, executives) and external (vendors, consultants and customers). Category of occupational fraud includes Asset Misappropriation, Financial Statement Fraud, Corruption.

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Association of Certified Fraud Examiners in their Report to the Nation (2022) state 86% of cases reviewed by them fall under Asset Misappropriation, 50% by Corruption and followed by 9% by Financial Statement Fraud. Combating Occupation Fraud for an organization, it is paramount task, no matter how stringent Anti-Fraud Policy in place, organization's suffer median loss of 5% as per Association of Certified Fraud Examiners. Occupational fraud does not impact just its organization where fraud as happened but it effects the industry and Country as whole and raises significant question on all the Anti-fraud Policies and all the control measures put in place by organization and governing bodies. Among the various mechanisms to fight fraud, Companies invest significant investment in Compliance Training, in educating its employees on What is Fraud, Its Impact to Self and Organization, Fraud Reporting. Governing Bodies made compulsory for organization to train their employees and conduct periodic reviews. Irrespective all this control measures, still we have witnessed multiple frauds and still many frauds are still unidentified.

REVIEW OF LITERATURE

Carolyn A. Strand, Steven L. Judd, and Kathryn A. S. Lancaster (2002): They opinioned in their paper, Manager's play crucial role in preventing fraud in an organization and they emphasis managers should ask themselves "What more we can do?" and they said employees are first to witness a suspicious activity after come the Management, Internal/External Auditors and Regulators, so it is important to train its employees on identifying the activity which is against the organization code of conduct, and training is more effective way to demonstrate Management commitment in fraud prevention and the ethical operations is organization's priority to its employees. And also, they said Case Study should part of the training curriculum because case studies allow an employee to evaluate a scenario and put the employee in a simulation-based learning which makes it more effective.

Louise Houlihan (2014): In her article on Employee Fraud, she opined that employee fraud scale is very high than the actual what most business thinks, and employee fraud is crucial which will impact the business not only in financial loss but also decrease in staff morale, reputational loss among suppliers, customers, business partners and business focus will increase on responding to fraud than accomplishing the commercial objectives. Employee fraud is a result of misplaced trust, inadequate hiring and poor internal control and she emphasis employee frauds is all about the opportunity, that is element which companies should be seeking to trim down, as a fraud prevention strategy successful implementation of strong internal control should begin with "tone at the top" and business owners and senior managers should lead by examples and any fraud identified and proved should be taken a serious action and not let the emotions take control and make way to compromise the act. And also business should balance between the risk involved and control measures and should not get into "Micro Management" of employees which affects the employees' morale.

Izedonmi, Famous, Ibadin Peter Okoeguale(2012):They opined that Frauds are widespread in modern organization, which have made the auditing and investigation inefficient and ineffective in the detection and prevention of the frauds, the fraud instants are continuing to increase across the private and public sector organization and across nations, Financial crimes happens in different shapes like employee theft, payroll frauds, fraudulent billing systems, management theft, insurance fraud, bribery, bankruptcy and so on. Financial crimes today have penetrated deep roots, and the advancement of computer software with added internet capability has doubled the problem of financial crimes. Besides, the detection or prevention of these crimes are made more difficult and committing these crimes much easier.

Association of Fraud Examiners (2016) In their report "Report to Nation on Occupational Fraud and Abuse" say that among 98 reported cases in South Asia between 2014 to 2016, Indian Contributes for 77 cases which are almost 79%, which is a very alarming number. And also, in its report says, India ranks second in terms of victim organizations reporting the cases. And in their survey conduct among the Certified Fraud Examiner's estimated that the typical organization loses 5% of revenues in a given year as a result of fraud. Asset misappropriation is common

organizational fraud. The study demands for the urgent need for regulators, professional community people to assess the risks emanating in the businesses.

Arpinder Singh(2016) In a report "Global Fraud Survey 2016" published by Ernst & Young(EY), Arpinder Singh, Head of EY Fraud Investigation & Dispute Services, India, and Bangladesh opined that corruption continues to be a significant risk for companies who deal with government bodies. Companies engaging with state-owned businesses and government departments need to have strong compliance programs in place, in order to be immune from these risks. And also he says 76% of companies have Anti-bribery and anti-corruption policies in place, but companies failed to realize that "paper-based compliance" will not suffice. And he recommends companies should use forensic data analytics to identify irregularities as a measure to prevent against fraud.

Research Gap / Statement of Problem:
During the course of my review of the literature, there is a clear understanding. Occupational fraud is most common and there is relaxed approach among the workforce, occupational fraud impacts the organizations achieving their goal and also directly it effects the country's economy at macro level. Unfortunately, effiencency of the training provided by the companies to their workforce are questionalble due to variouse reason inlcuding, Job/Grade based trainging, relvance of topic to the employee, Management role in delivering training, impact analysis on training outcome etc..

With the above discussion leads to the following research question.
1. Is there is a positive approach towards Compliance Training among the workfoce?
2. Does Complaince Training to the workforce will reduce fraud instance in the organisation?
3. Does Complaince Training help in delivering better corporate governance?
4. Does management play role in Compliance Training and its success?

Scope of the Study
This empirical study will be basically a step towards efficiency of Compliance Training on occupational fraud prevention. Since these influences, the corporate and economy in an integral part, an attempt will be made to study the effectiveness of Compliance Training as a tool to mitigate fraud and to evaluate compliance Training for better work ethics among the Multinational workforce.

Objectives of the Study:
1. To assess the process of Compliance Training provided in Multinational Companies.
2. To examine the structure and delivery of Compliance Training
3. To assess the effectiveness of compliance training in preventing occupation fraud

Hypothesis
1. There is no significant effect of employee experience on Compliance Training results
2. There is no significance of Compliance Training on employee response to react to fraudulent activities

RESEARCH METHODOLOGY

This study is to report the significance of Compliance Training for occupational fraud prevention, right education acts an integral part in any success of business, since many a times ignorance and knowledge gaps results in failure of controls. In achieving the objective of this study, primary data is used. Primary data was collected through structured questionnaire, which was designed in the five-response option of Likert-scale and administered from multinational companies' workforce covering Front Line, Managers, Audit and Control, Human Resource and Training & Development Professionals and data are analyzed through Descriptive Statistics, reliability was checked

using Crombach Alpha and it is estimated as 0.837 for content, .894 for response and .856 for environment. Structural Equation Model is used to establish the relationship

Data Analysis and Interpretation
Inference
The response profile of this research from Table 1 shows that the 67.7% of the respondents are of less than 10 years while 48.6% of the respondents are of frontline employees and 40% of them are managers. A 58.6% of the respondents are of Post graduates avnd 88.6% of the respondents are in the age group of 20-40 years.

Objective 1: To assess the process of Compliance training provided in Multinational Companies.
Inference
The table 1 shows that 60% compliance training is conducted after identifying a trend for a specific fraudulent activity or based on internal auditing or annual auditing. 40% respondents are based on routine awareness program. The response from Table 2 shows that 70.45% of the respondents attended training using a single mode while 12.27% used two modes for training. 85.45% respondents used e learning while 14.09% used video-based learning. Only 25.56% respondents experienced multimodal training in the companies. Small firms prefer single modal training and these points are discussed in learning circles as well. In companies, compliance training is encouraged in a virtual platform than in a real time format. So, e-learning is used more followed by video-based training.

Inference
The table 3 and 4 shows that all the fourteen points were discussed in only one firm has covered all points and it is clear that Organizational Anti Fraudulent Activities (69.86%), privacy and data collection (79.91%), cyber security (64.84%) and compliances in fraudulent activities are the highly discussed in training and sales compliance polices are least discussed topic.

Objective 2: Structure and Delivery of Compliance Training.
Inference
The table 5 shows that training is delivered on quarterly and annual basis prominently, E-learning is most common and training is employee centered and self-learning based, Instructor Lead is least training mode across all time interval.

Inference
The above table shows that organizational level Fraudulent activity control is more emphasized followed by cyber security and compliance regulation. The least discussed point is sales compliance across all time interval.

Hypothesis Testing
There is no significant effect of employee experience on responding to Compliance Training
Descriptive Analysis

Variable	<10 years		10-20 years		Total	
	Mean	Std. Deviation	Mean	Std. Deviation	Mean	Std. Deviation
Conduct Compliance Training?	4.23	.574	4.31	.767	4.26	.642
Frequency of Compliance Training	4.15	.623	4.31	.646	4.20	.633
Modes of Delivery	3.87	.710	3.63	1.085	3.80	.854
Topics covered	3.77	.745	3.11	1.260	3.56	.989
Appropriateness to job	4.07	.659	4.06	.984	4.07	.776

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Awareness on Purpose of the Compliance Training	4.09	.667	3.97	.971	4.05	.778
Content based Training material	4.17	.550	4.35	.635	4.23	.584
Position based Training material	4.10	.714	3.97	.654	4.06	.696

Log Determinants

Experience (Years)	Rank	Log Determinant
<10 years	8	-12.635
10-20 years	8	-8.235
Pooled within-groups	8	-9.579

The ranks and natural logarithms of determinants printed are those of the group covariance matrices.

Test Results

Box's M		358.293
F	Approx.	9.489
	df1	36
	df2	68989.652
	Sig.	.000

Wilks' Lambda

Test of Function(s)	Wilks' Lambda	Chi-square	df	Sig.
1	.813	44.248	8	.000

Inference

Wilk's Lambda is statistically significant and it shows that experience cause variance in organizing Compliance Training and benefiting from Compliance Training, hence alternate Hypothesis is accepted.

Classification Function Coefficients

	Experience (Years)	
	<10 years	10-20 years
Conduct Compliance Training?	6.096	6.779
Frequency of Compliance Training	3.121	3.824
Modes of Delivery	-.329	-.482
Topics covered	3.030	2.298
Appropriateness to job	.322	.540
Awareness on Purpose of the Compliance Training	-6.412	-7.249
Content based Training material	10.420	11.418
Position based Training material	2.413	1.750
(Constant)	-39.375	-41.264

Inference

Awareness on purpose of Compliance Training has a negative coefficient while content-based training has a coefficient. Compliance training organizing also has a coefficient,

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Structural Equation Model: Effect of Compliance Training on Response

Hypothesis: There is no significant of Compliance Training on employee response to react to fraudulent activities

There are three observed variables in this analysis: Content, Environment and Response. The response contains six variables to show how the respondents respond to the fraudulent activities. The previous results show that there is a short-term objective in developing an awareness among employees at organizational level. The content contains topics covered, appropriateness to job, awareness on purpose of the Compliance Training, Content biased training material, position-based training, assessment of compliance training, and effectiveness. Awareness on purpose of Compliance Training and position-based training have high regression coefficient.

Impact of fraud on losses, conforming to code of conduct, answering ambiguous questions and cautious work environment are the environmental factors. All have a higher regression coefficient. The responses include, zero tolerance on fraudulent activities, anonymous reporting, confidence in reporting crime, reporting fraudulent activities, seeking report and education on fraud are important. All the variables in the respondent have high regression coefficient. The covariance between content and environment positive, but low. The regression coefficient of content on response is 1 and it shows a good effect and the same of environment on response is 0.26. The SEM model is a recursive model. The model fit variables like, CMIN/DF (4.56), RMR (.064). GFI (.896) and RMSEA (.056). The model shows that the Compliance Training is effective and employees are motivated for the same.

Inference

The SEM models shows that the Compliance Training is effective and employees are motivated to report fraudulent activities, hence alternate hypothesis is accepted.

CONCLUSION

The results shows that the employers of the respondents take the compliance training serious and implement the system effectively. The high dependency on e-learning may not give the expected results since its more employee centered and evaluation mechanism is more of open book model hence, more interactive sessions needed like instructor led training which more effective also that will encourage the employees to interact better any get any question addressed. Though 14 points are considered for compliance, the respondents attended mainly only in three points, Organizational level anti fraudulent activities, cyber security and compliance regulation. Sales compliance is the least discussed. Occupation Fraud cannot be completely eradicated but can be controlled with shared effort from organization and regulators, most of the fraud are identified from the tip received from front line employees, hence educating the workforce on Fraud, Fraud Reporting and giving confidence on any the information received from internal (employee, managers, executives) or external (vendors, consultants and customers) will be dealt confidentially without any repercussion. Training is mode where organization communicate to its employees on their commitment on fraud preventions and zero tolerance on fraud, hence effective compliance training will help organization overall in fighting occupational fraud.

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Table 1: Response's Profile

		Frequency	Percent	Valid Percent	Cumulative Percent
Gender	Male	126	57.3	57.3	57.3
	Female	94	42.7	42.7	100.0
Age	21-30	74	33.6	33.6	33.6
	30-40	121	55.0	55.0	88.6
	40-50	25	11.4	11.4	100.0
Education	Graduation	91	41.4	41.4	41.4
	PG	129	58.6	58.6	100.0
Department	Frontline Employee	107	48.6	48.6	48.6
	Manager	88	40.0	40.0	88.6
	Controls/Auditor	4	1.8	1.8	90.5
	HR	17	7.7	7.7	98.2
	Training &Development	4	1.8	1.8	100.0
Experience	<10 years	149	67.7	67.7	67.7
	10-20 years	71	32.3	32.3	100.0

Table 2: Mode of Compliance Training Delivered in Multinational Companies

Number of Modes used	E-Learning	Video-Based Training	Coaching	On the Job Training	Video Based Learning	Interactive Training	Instructor Lead Training	Case Studies	Total	%
7	1	1	1	1	1	1	1	0	1	0.45
4	8	6	1	3	4	4	2	8	9	4.09
3	18	5	2	9	6	8	5	7	19	8.64
2	26	5	2	1	14	3	1	4	27	12.27

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1	135	2	0	7	6	4	0	1	155	70.45
0	0	0	0	0	0	0	0	0	9	4.09
Total	188	19	6	21	31	20	9	20	220	100.00
%	85.45	8.64	2.73	9.55	14.09	9.09	4.09	9.09	100.00	

Table 3. Topics discussed under Compliance Training.

	organizational Anti Fraudulent	Emerging fraud Risks	Privacy &Data Protection	Industry& Organization specific risk	Cyber security Fraud	Social Engineering	Past fraud cases	Count	%
14	1	1	1	1	1	1	1	1	0.46
13	33	33	33	33	33	33	33	32	14.61
12	4	4	4	4	4	3	4	4	1.83
11	7	5	7	7	7	7	6	7	3.2
10	3	2	3	2	3	1	1	3	1.37
9	4	1	4	1	4	3	2	4	1.83
8	10	5	9	3	9	4	6	10	4.57
7	24	10	23	3	23	5	7	24	10.96
6	12	4	13	2	12	5	1	14	6.39
5	15	9	20	6	18	5	3	23	10.5
4	6	2	9	5	9	1	0	10	4.57
3	14	1	21	7	14	1	0	28	12.79
2	6	0	4	0	5	0	0	9	4.11
1	14	0	24	0	0	0	0	41	18.72
0	0	0	0	0	0	0	0	9	4.11
Total	153	77	175	74	142	69	64	219	
%	69.86	35.16	79.91	33.79	64.84	31.51	29.22	100	

Table 4. Topics discussed under Compliance Training.

	Fraud repo	Money Laun-Dering	Red flags of fraud	Bribery & Corruption	Compliance in fraudulent activities	Anti corruption	Sales Compliances	Count	%
14	1	1	1	1	1	1	1	1	0.46
13	33	33	33	33	33	33	0	32	14.61
12	4	4	2	3	4	4	0	4	1.83
11	5	6	6	7	4	3	0	7	3.2

10	3	3	2	2	3	2	0	3	1.37
9	2	4	4	4	2	1	0	4	1.83
8	6	7	5	5	7	4	0	10	4.57
7	14	16	2	11	16	14	0	24	10.96
6	6	3	6	5	11	4	0	14	6.39
5	8	5	3	5	12	3	3	23	10.5
4	2	0	0	1	3	1	1	10	4.57
3	0	2	0	4	16	4	0	28	12.79
2	0	3	0	0	0	0	0	9	4.11
1	0	0	0	0	3	0	0	41	18.72
0	0	0	0	0	0	0	0	9	4.11
Total	84	87	64	81	115	74	5	219	
%	38.36	39.73	29.22	36.99	52.51	33.79	2.28	100	

Table 5: Compliance Training Mode and Frequency of Training Conducted.

Frequency	E learning	Coaching	OJT	Video	Interactive	Instructor lead	Case Study
Monthly	17	1	0	4	2	0	0
	7.8%	.5%	0.0%	1.8%	.9%	0.0%	0.0%
Quarterly	93	1	1	9	5	2	7
	42.9%	.5%	.5%	4.1%	2.3%	.9%	3.2%
Semi-Annually	22	0	2	9	4	1	3
	10.1%	0.0%	.9%	4.1%	1.8%	.5%	1.4%
Annually	53	4	18	9	9	6	10
	24.4%	1.8%	8.3%	4.1%	4.1%	2.8%	4.6%
	185	6	21	31	20	9	20
Total	85.3%	2.8%	9.7%	14.3%	9.2%	4.1%	9.2%

Table 6: Compliance Topic and Frequency of Training Conducted.

Frequency	OAFP	Emerging Fraud risk	Privacy & data Protection	Industry & Organization based risk	Cyber security	Social Engg	Past fraud history
Monthly	18	17	21	11	21	14	12
	8.30%	7.8%	9.7%	5.1%	9.7%	6.5%	5.5%
Quarterly	59	28	74	25	51	19	19
	27.20%	12.9%	34.1%	11.5%	23.5%	8.8%	8.8%
Semi-Annually	24	17	27	15	21	13	12
	11.10%	7.8%	12.4%	6.9%	9.7%	6.0%	5.5%
Annually	52	15	53	23	49	23	21

	24.00%	6.9%	24.4%	10.6%	22.6%	10.6%	9.7%
	153	77	175	74	142	69	64
Total	70.50%	35.5%	80.6%	34.1%	65.4%	31.8%	29.5%

Table 7 Compliance Topic and Frequency of Training Conducted.

Frequency	Fraud reporting procedure	Money laundering	Red flags of fraud	Bribery	Compliance regulation	Authorised Practices & Control	Sales Compliance
Monthly	17	13	12	10	13	12	1
	7.8%	6.0%	5.5%	4.6%	6.0%	5.5%	.5%
Quarterly	23	27	21	24	41	22	0
	10.6%	12.4%	9.7%	11.1%	18.9%	10.1%	0.0%
Semi-Annually	15	13	11	13	22	12	0
	6.9%	6.0%	5.1%	6.0%	10.1%	5.5%	0.0%
Annually	29	34	20	34	39	28	4
	13.4%	15.7%	9.2%	15.7%	18.0%	12.9%	1.8%
	84	87	64	81	115	74	5
Total	38.7%	40.1%	29.5%	37.3%	53.0%	34.1%	2.3%

SEM Relationship on Content, Response and Environment

REVIEW ARTICLE
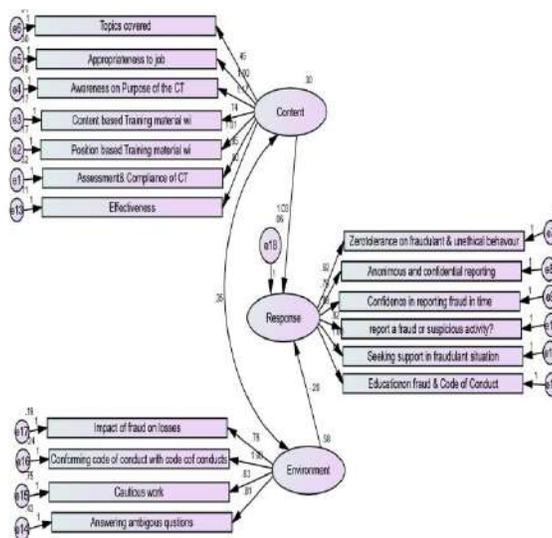
Factors Influencing Purchase/ Adoption of Solar Technology among Industrial users in Bengaluru

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ABSTRACT

The current economic and social system still relies on traditional energy sources and distribution systems and takes time to allow for the acceptance of renewable energy sources by the current economic and social system. People are currently able to choose their electricity suppliers to choose between traditional and renewable sources. Industrial consumers must examine a wide variety of factors which may influence their choice. The purpose of this research is to determine which factors influence the knowledge, perception, attitude, acceptance and procurement of solar energy of industry clients both internal and external. In addition, adjustments to solar renewable energy marketing technique could be proposed in order to reach industrial masses for renewable energy products. Certainly, this analysis is descriptive in nature. Primary data is obtained from (Managers) industrial users. 112 respondents are estimated on the basis of the Cochran Method of uncertain population sample size. The questionnaire is divided into four sections including Rating scale and Likert scale questions and the questionnaire's convergent-divergent validity is also tested. The data analysis is performed by explaining the rankings and then using SPSS Version 25 Tools to test the hypothesis. The study's focus is geographically restricted to Industrial users in Bengaluru. The findings of the study show that majority of factories in Bengaluru encounter power cuts 1 to 2 times in a month and use diesel generators. A majority of the industrial users said that they use HT Power. There is a need to market the solar energy to these organizations. The various responsible and resisting factors are identified in the study. 14 responsible and 9 resisting factors influence the decision of the industrial users to adopt solar technologies The aim of this study is to develop marketing strategies that maximize solar energy products production, adoption and acquisition. The utilization of solar energy will contribute to the development of the future. It will be helpful to understand how to market Solar Energy Products, given that very few promotional and

marketing policies are currently in place in this field. As a result of research, the most important factors that influence solar marketing will be identified and marketing areas can be identified that help manufacturers and suppliers of these products to grow sales as a result of increased use of solar energy products. It will benefit the government, which is untiringly working to promote the use of renewable energy resources to achieve sustainable development over the long term. Because of their contribution to environmental preservation, the ultimate buyer will also feel a sense of achievement.

Keywords: Solar technologies, solar energy, Industrial users, Attitude, perception

INTRODUCTION

India, with a population of over 1.25 billion individuals, exhibits a substantial and pressing need for energy resources at present. India is positioned as the sixth largest country globally in terms of both power generation capacity and power consumption. In recent times, there has been a notable surge in electricity output, exhibiting a growth rate that closely approximates the corresponding growth rate observed in the nation's population. Approximately 53% of India's electrical generation is derived from coal, while the nation's coal reserves are projected to remain sufficient until the year 2050. A significant proportion of India's population primarily resides in rural regions, where a substantial majority (72%) continues to have challenges in accessing dependable energy sourcesRauf, A., Nureen, N., Irfan, M., & Ali, M. (2023). The increasing necessity to bridge the disparity between energy demand and supply has prompted a heightened interest in solar power as the most feasible resolution. India is geographically located between the Tropic of Cancer and the Equator, rendering it a favorable region for the utilization of solar energy. In this particular geographical area, the yearly mean temperature ranges from 24°C to 28°C. Consequently, an estimated quantity of 5,000 trillion kilowatt-hours of solar energy is accessible, accompanied by an excess of 300 days characterized by abundant sunshine. India has gained recognition as a prominent nation in the field of solar energy harvesting due to the implementation of numerous solar laws and programs at both the state and central government levels, as part of the National Solar MissionKhanna, M. K., Malik, S., & Kumar, H. (2023). The proliferation of solar photovoltaics in India is expected to be expedited in the coming years, as shown by a report jointly released by BRIDGE TO INDIA and GTM Research. The solar industry in India exhibits significant potential for expansion. It is anticipated that a majority of forthcoming electronics would rely on a solar-powered rechargeable battery bank for their energy supply. The increasing need for power and the growing recognition of the advantages associated with renewable energy sources have stimulated the development of novel technology capable of harnessing the ample solar radiation.Batool, K., Zhao, Z. Y., Irfan, M., Ullah, S., & Işik, C. (2023).

Presently, the prevailing economic and social framework continues to rely on conventional energy sources and distribution networksRoy, S., & Mohapatra, S. (2022). Consequently, the integration and acceptance of renewable energy within this system will require a considerable amount of time. Subsequently, consumers now have the ability to choose their electricity supplier based on their preference for either conventional or sustainable energy sources. Industrial consumers must consider several criteria in order to make a well-informed decision. Moreover, it is worth noting that renewable energy sources need a substantial initial investment Sadhu, M., Chakraborty, S., Das, N., & Sadhu, P. K. (2015). The hindrance of renewable energy marketplaces in India, which has impeded the widespread adoption of renewable energy, can be attributed to substantial state subsidies allocated to fossil fuels and the limited purchasing power of potential customers. This study aims to investigate the extent of market penetration achieved by conventional funding and financial instruments such as capital subsidies, donor grants, tax rebates, and fiscal incentives. However, the focus of this study is to analyze the widespread adoption and commercialization of renewable energy products and technologies by end usersHairat, M. K., & Ghosh, S. (2017). To achieve this, it is necessary to reassess product selection and evaluate the financial implications associated with this adoption. The objective of this study is to ascertain the internal and external factors that influence the solar energy literacy,

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perspective, attitude, and acceptance of industrial clients, as well as their subsequent purchase choices. In order to achieve widespread availability of solar renewable energy commodities in the industrial sector, it is imperative to propose novel strategies for advertising these products. The first section of the study gives an overview of the solar energy and its acceptance in India. The second section focusses on the review of literature. The research methods are specified in the third section and the fourth section presents the results of the study. The last section of this research concludes with limitations and scope for further research.

REVIEW OF LITERATURE

This study employed a systematic literature review approach to analyze previous scholarly works that were pertinent to the research inquiries under investigation. The articles were sourced from reputed journals and were scrutinized to determine the level of quality exhibited by each study. Elsevier database, Routledge and CRC Press Taylor and Francis database, Emerald Group Publishing database, Springer Nature database and Sage database. Several supplementary articles were acquired from reputable academic databases such as Wiley, Academia, JSTOR, and Guildford Press.

Kumar, C. M. S & et al, (2023) India is the world's fifth largest economy, and its agricultural and associated industries account for 20% of GDP. Activities such as plowing, watering, planting, harvesting, storing, and processing food are all part of the agricultural sector. Renewable solar energy has emerged as a major energy source that can minimize farmers' reliance on the usage of conventional energy sources in India, where there is a current agricultural energy need. Regular use of fossil fuels depletes these resources and emits massive amounts of carbon dioxide into the air. By 2050, it is predicted that 4 gigatons of CO_2 emissions might be avoided annually if solar power installations reached 4600 GW. Therefore, solar energy has been identified as a potentially game-changing renewable resource for the generation of thermal energy and electrical power for use in agricultural and industrial applications. Li, L., Lin, J., Wu, N., (2022) The use of renewable energy sources is increasingly being considered as a viable solution to the world's energy and environmental crises. Sustainable development calls for energy efficiency and greenhouse gas emission reduction policies and methods. Burton, N. A., Padilla, R. V., Rose, A., & Habibullah, H. (2021) The rise in human-caused disruption has resulted in a dramatic increase in worldwide demand for energy. McPherson, M., & Stoll, B. (2020) Real-world load data from Bengaluru, India is used to evaluate the proposed demand response system. By allowing for the replacement of high-marginal-cost thermal generators with near-zero-marginal-cost renewables, the results show that demand responsiveness reduces production costs. The utilization rates of demand responses are often limited by their maximum permissible daily deployment, while their operating behavior is governed by intraday recovery limitations. Furthermore, demand response aggregators might anticipate sizable income from price arbitrage on top of the huge value that demand response brings to the grid. Kabir, Ehsanul & et al (2017), the creation of innovative solar power technologies is regarded as a crucial approach to meeting the escalating global energy needs. The field of solar technologies is experiencing rapid growth, however, it is encountering several technical obstacles. These include low solar cell efficiencies, underperforming Balance-of-Systems (BOS), economic challenges such as high upfront costs and lack of financing mechanisms, as well as institutional barriers such as inadequate infrastructure and a shortage of skilled manpower. T. Hoang & X. P. Nguyen (2021) The smart city's energy system is crucial to its overall mission of creating a more sustainable urban environment. The use of renewable energy sources has also been shown to significantly contribute to lowering pollution levels and improving the quality of the surrounding environment.Nwaigwe, K. N., Mutabilwa, P., &Dintwa, E. (2019) Incorporating solar energy into non-renewable sources is important because it slows down the rates at which those sources are consumed, integration technology has become important due to the world's energy requirements, which imposed a significant need for different methods by which energy can be produced or integrated.

Gram-Hanssen, K., M. H. Jacobsen, & A. R. Hansen (2022). A big group of early adopters (annually metered) and a smaller group of later adopters (hourly/real-time metered) in Denmark have solar photovoltaics (PVs) due to lower costs and stop-go policies. Sadamoro, F., Ajayi, O. M., Ayodel, O. O., & Areola, T. O. (2023). The research suggests

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that in order to uphold customers' trust and commitment, solar power companies should establish a clear strategic plan and an effective system for handling customer complaints. Kumar, V., Syan, A. S., & Kaur, K. (2022) The findings of the study indicate that various factors, including rising energy costs, familiarity with the product, financial assistance and incentives, and perceived expenses, have a favorable impact on consumers' inclination to acquire solar water heaters. Vuichard, Stauch, and Wüstenhagen (2021) The results indicate that social acceptance can be enhanced through the implementation of local ownership and the utilization of colored solar panels that minimize the perceived alteration of the landscape. This implies that projects should prioritize a localized and unobtrusive approachAlam, S. A & Khan, S.M. (2017). Studies have indicated that the level of approval for alpine solar projects is greater among individuals residing in the affected areas as compared to those who reside in non-alpine regions. Kumar, V., Hundal, B. S., and Syan, A. S. (2020). The dimensions encompassing environmental knowledge, promotion and advertisement, environmental concern, and peers influence were deemed insignificant in relation to the customer attitude towards solar energy products.Ali, S., Dogan, E., Chen, F., & Khan, Z. (2021).

Hypothesis development

There exist multiple factors that exert effect on industrial users' decision to use solar energy. Several causes contribute to the adoption of renewable energy sourcesÃ, J. M., & Truffer, B. (2006). These factors encompass the escalating expenses associated with conventional energy sources, the growing recognition of environmental sustainabilityAbbasi S.A., Abbasi Naseema (2001) and the accessibility of governmental incentives and tax advantages for utilizing renewable energy. Furthermore, recent progress in solar technology has resulted in increased efficiency and improved cost-effectiveness, rendering it a compelling choice for industrial consumers seeking to diminish their environmental impact and achieve long-term energy savingsAdenle, A. A. (2020). Consequently, an increasing number of enterprises are currently adopting solar energy as a feasible and enduring resolution for their energy requirements. Occasionally, the drawbacks of a particular phenomenon surpass its advantages, exemplified by the considerable upfront expenses associated with installation and the reliance on sunlight as the sole source of energy generation. Moreover, the sporadic nature of solar electricity presents difficulties for companies that necessitate a steady and uninterrupted power provisionAmbepitiya, Kalpana. (2015). Notwithstanding these obstacles, the collective advantages of solar energy, encompassing its ecological compatibility and capacity for enduring financial gains, render it a persuasive option for several sectors. Industries can effectively address the aforementioned difficulties and maximize the utilization of solar energy by making strategic investments in storage technology and integrating intelligent grid systems.

Hence, the research Question
-      What is the impact of responsible and resisting factors in adoption of solar energy?

H1 - Responsible and resisting factors influence the adoption of solar technologies by Industrial users in Bengaluru

RESEARCH METHODS

According to Haydam, N. E., and Steenkamp, P. (2021), the research process can be visualized as an onion with each layer representing a progressively more comprehensive step. Based on the research Onion model the current study is a positivism approach which is deduced from previous studies onsolar energy. Owing to its nature, the study is a mono method quantitative analysis which uses industrial power users as the participants of the study. The current study is descriptive in nature. Primary data was gathered from industrial users who are power department managers or heads; the obvious reason for choosing them is that they are the decision makers in their enterprises on whether or not solar technologies should be installed. The sample size is computed at 112 respondents using the Chaokromthong, K., and Sintao, N. (2021)Cochran Formula for an unknown population with a 95% confidence level and a 10% margin of error. The Questionnaire is built using the variables identified in the research reviewMorrison, R. L., Dillman, D. A., & Christian, L. M. (2010). The questionnaire is organized into four sections, each of which contains demographic information about the respondents, an industry profile, factors preventing (Resisting) solar energy adoption, and factors promoting (Responsible) solar energy adoption. The questionnaire uses Likert scale questions, and its convergent-divergent validity is also examined, with the statistics falling within acceptable limits.

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The variables in the study are divided into Dependent Variables, which represent solar technology adoption, and Independent Variables, which represent the causes preventing and causing solar technology adoption. The data analysis is completed by displaying descriptive statistics and then testing the hypothesis with SPSS Version 25 and AMOS R Version 23 softwareCollier, J. (2020). The study's geographical scope is limited to Bengaluru district in Karnataka state of India and Industrial Consumers; the study is focused on factors influencing solar energy adoption and cannot be applied to other products or services.

RESULTS AND DISCUSSION

This section presents the results obtained from the managers of industries in Bengaluru. Firstly, the demographic and the Industrial profile are discussed followed by an item analysis of the responsible and resisting factors. The SEM analysis for the factors is conducted following the exploratory factor analysis results.

Demographic profile of the Industrial Managers
A majority of 94.9% of managers in the study are male, and only 5.1% are female. This huge gender disparity is due to the fact that there are very few women employed in the factories as compared to the other service sectors, and as the study concerned managerial employees, there is very little role for women at higher levels in the factories. A majority of 62.7% of managers in the study belong to the 26–45 year age bracket, and 33.4% of managers are between 46 and 65 years old. A small percentage of 1.9% of managers are above 66 years old and below 25 years old. 41.8% are engineering graduates, and 39.2% have completed their post-graduation. Only 8% of employees had an interim diploma. 9% of managers in the study are from finance and accounting backgrounds. 39.5% of the employees in the study are utility or electrical maintenance managers; 15.4% are procurement leads or sourcing leads; 9.6% are directors, heads, or presidents of factories; and 7.4% are consultants,and 13.8% are Finance Managers or Assistant Finance Officers. A majority of the 64.3% of managers in the study have more than 16 years of experience. 13.5% of employees have 11–15 years of experience. 19.6% of employees have 5–10 years of experience in the factories. A small percentage of 2.6% of employees have less than 5 years of experience.

Profile of the Industrial users in the study
30.5% of industrial power consumers in the study are located in the urban area, 16.1% are in the semi-urban area, and 18.3% are located in the rural area. The industrial parks and industrial suburbs have 20.3% and 14.8% factories, respectively. 56.6% of industries run on a small scale and operate on a small or microscale level, engaged in the manufacturing, production, and provision of services. 33.4% are manufacturing enterprises and service-rendering enterprises. A majority of 93.9% of industrial consumers receive power supply from the licensee at a high voltage. As per the Indian Electricity Act, high-tension consumers are required to uphold a power factor range of 0.9 to 0.99, and a small 6.1% are low-tension power consumers. Only 16.7% of industrial power consumers use solar power, 32.8% use wind power, and 31.8% use both solar and wind power. 26.7% of industrial power consumers expressed that they face power cuts 1-3 times a month; another 26.7% of industrial power consumers face power cuts about 4–8 times a month, which is very high. 46.6% agreed that power cuts are very rare.
Item analysis for responsible and resisting factors

There are 9 resisting factors and 14 responsible factors identified through extensive review of literature. Industrial users show agreement towards both resisting and responsible factors which is indicated by the mean scores which are above 3.500. The standard deviations are below 1.500 indicating less variation in responses and the measures of skewness and kurtosis are within the acceptable range of -3.00 and +3.00 indicating normal distribution of data.
H1 - Responsible and resisting factors influence the adoption of solar technologies by Industrial users in Bengaluru

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Step -1 Exploratory Factor analysis

The KMO measure of sampling adequacy, which is equal to 0.878, and Barlett's Test of Sphericity, which comes with a significance level of 5%, are statistically significant. It was found by chi-square analysis that the Chi-square value of the Bartlett test is 30209.750 with the significant value less than 0.05 and 127 degrees of freedom, which shows that correlation matrix, is not an identity matrix and that it looks to be factorable. Communalities refer to the extraction values for each of the items and should be above 0.300 and the communalities for stress items were between 0.487 and 0.879. The total of squared loadings that has been removed accumulates to about 83.737 % of the original loadings. In social sciences, a cumulative Rotation Sums of Squared Loadings is considered good if it is above 50%. 2 components are discovered while applying the approach of Factor Analysis, according to the results of the study. The rotated component matrix showed that due to the appropriate factor loadings no items were deleted in the study. 9 Resisting factors and 14 responsible factors were considered for the study.

STEP -2 Run the Model

The table above displays the essential statistics for model fit. The chi-square divided by degrees of freedom ($\chi2 / df$) falls within the acceptable range of 3 (specifically, 2.876). The observed Goodness of Fit value (0.826) surpasses the proposed attributes. The boundary estimation yields a value of 0.048 for the RMR. The model in question has garnered significant recognition within the academic community, and its measures of fit are reasonably appropriate.

The results of the structural model presented in table 2 show that -
- One unit increase in mean scores of resisting factors will lead to 30% decrease in adoption of solar technologies and this relationship is statistically significant at (B=0.296, b=0.112, p=0.000)
- One unit increase in mean scores of responsible factors lead to 12% increase in the adoption of solar energy by industrial users and this relationship is statistically significant at (B=0.116, b=0.083, p=0.000)

A one-unit rise in the average scores of factors that resist the adoption of solar technologies is associated with a 30% decrease in the likelihood of adopting those technologies. This discovery implies that persons who perceive a greater prevalence of obstacles to adoption are less inclined to embrace solar technologies. The factors that impede the adoption of solar energy can include significant upfront expenses, limited knowledge about the advantages of solar power, or apprehensions regarding the dependability of solar technology. Hence, it is imperative for policymakers and industry stakeholders to acknowledge and tackle these concerns, while offering more support and incentives to promote the extensive implementation of solar technologies. However, it should be noted that there is a positive correlation between an increase in the average scores of responsible variables and a 12% rise in the adoption of solar energy among industrial users. By acknowledging and mitigating these variables that impede progress, governments and industry stakeholders can facilitate the surmounting of obstacles hindering the widespread implementation of solar technologies. The observed increase in adoption rates among industrial users, as shown by a 12% rise in mean scores of relevant factors, suggests a potential for substantial growth in the utilization of solar energy. This underscores the significance of establishing a conducive atmosphere for the use of solar energy by means of educational initiatives, financial incentives, and technological progress. The standardized estimates indicate that the factors that oppose the adoption of solar electricity have a substantial impact on the decision-making process of industrial customers. This observation suggests that it is imperative to tackle these sources of resistance in order to enhance the uptake of solar energy among industrial consumers. Moreover, the provision of additional support and incentives has the potential to surmount these challenges and foster increased adoption of solar technologies. Through acknowledging the influence of accountable elements and effectively addressing the opposing variables, policymakers and industry stakeholders possess the ability to provide a conducive atmosphere that facilitates the extensive integration of solar energy.

CONCLUSION

The adoption of solar energy is hindered by various sources of resistance. To enhance the uptake of solar energy, marketers should prioritize the mitigation of these problems. One potential strategy is implementing educational and awareness initiatives aimed at addressing potential misconceptions and apprehensions among customers regarding solar energy. Furthermore, the provision of financial incentives and subsidies can serve as a viable approach to mitigate the initial financial burden linked to the installation of solar panels. By taking proactive measures to address these factors of resistance, marketers can contribute to expediting the process of transitioning towards a future characterized by sustainability and clean energy. The implementation of solar electricity by industrial entities not only has the potential to mitigate their carbon emissions but also offers substantial long-term cost savings. By leveraging solar energy, businesses can reduce their dependence on conventional energy sources, leading to decreased electricity expenses and enhanced financial performance. In addition, the incorporation of solar energy into many businesses has the potential to stimulate innovation and generate employment prospects within the renewable energy field. In general, the implementation of solar electricity among industrial consumers presents a mutually beneficial scenario that yields advantages for both ecological preservation and economic prosperity. The imperative for the Government to engender awareness and mitigate barriers to the adoption of solar power is evident. The government may foster the adoption of renewable energy among businesses by enacting rules and providing incentives that specifically promote the utilization of solar power in industrial sectors. One such approach involves the dissemination of knowledge to businesses regarding the enduring financial advantages and ecological merits linked to the utilization of solar energy. Furthermore, governmental entities have the capacity to offer monetary aid and tax incentives as a means of mitigating the initial capital outlay associated with the installation of solar panels. Through strategic intervention, the government can assume a pivotal position in expediting the integration of solar power within various industrial sectors, thereby facilitating the progression towards a more environmentally sustainable trajectory.

SCOPE FOR FURTHER RESEARCH

Future researchers are anticipated to focus their efforts on exploring alternative geographical areas characterized by abundant solar radiation. The study can also encompass residential power consumers. Also, it would be advantageous for forthcoming researchers to investigate the potentiality of utilizing solar energy in regions characterized by ample sunlight, such as arid deserts or tropical areas. Through the examination of these specific geographical areas, it is possible to cultivate enhanced solar energy systems that possess heightened efficiency, hence facilitating the provision of sustainable power to accommodate the expanding global populace. In addition, broadening the scope of the investigation to encompass residential power consumers would afford us the opportunity to get insights into the viability and advantages of integrating solar energy on a more localized level. This might potentially result in a reduction of carbon emissions and a decreased reliance on conventional energy sources. Future researchers have the opportunity to employ a mixed research methodology that incorporates qualitative analysis. This would entail the collection of data from inhabitants residing in these geographically sun-drenched areas via surveys and interviews, with the aim of comprehending their energy consumption patterns and requirements. Furthermore, the application of quantitative analysis can be employed through the collection of data pertaining to solar energy generation and its subsequent influence on domestic power consumption. By integrating qualitative and quantitative methodologies, forthcoming researchers can get a holistic comprehension of the prospective advantages and obstacles associated with the implementation of solar energy in diverse home contexts.

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Table -1 Item analysis for responsible and resisting factors influencing adoption of solar energy by Industrial users

	Mean	Std. Deviation	Skewness	Kurtosis
Resisting_factors_1 Solar energy has become less affordable	4.36	1.124	-0.392	-0.884
Resisting_factors_2 Performance records for solar systems in India is available only for a minimal period and hence decision making is difficult	4.11	0.677	-0.134	-0.806
Resisting_factors_3 Making decisions on purchasing solar energy products is based on longevity and efficiency	3.75	0.690	0.365	-0.870
Resisting_factors_4 Larger investment on solar energy systems is a hindrance	3.25	0.876	-0.515	0.020
Resisting_factors_5 Sales promotion methods Influence the purchase decision	3.22	1.019	-0.652	-0.473
Resisting_factors_6 Previous bad experiences hinder the purchase of solar energy systems	3.71	0.794	-0.301	-0.244
Resisting_factors_7 Absence of priority sector financial assistance from Lenders and Nationalized bank is a hindrance to make quick decisions	3.26	1.046	-0.541	-0.325
Resisting_factors_8 Signing long term solar power purchase agreements under the Build, Own and Operate model is a major road block towards opting for solar power	3.48	0.923	0.046	-0.817
Resisting_factors_9 Non-availability of credible solar power players	3.30	0.941	0.190	-0.862

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Responsible_factors_1 Prefer to use solar energy products because it is eco-friendly and reduces carbon emission.	4.21	0.863	-1.785	4.687
Responsible_factors_2 Prefer to use solar energy technology products to reduce the electricity bill to a significant extent	4.22	0.822	-1.209	1.418
Responsible_factors_3 Prefer to use solar energy to reduce Diesel usage through Diesel Generators during Power Cuts due to frequent power cuts	3.51	1.040	-0.349	-0.502
Responsible_factors_4 Prefer to use solar energy systems to get government subsidies	3.43	1.184	-0.877	0.079
Responsible_factors_5 Prefer to use solar energy systems to get tax deductions or other IT benefits extended by the Government	3.35	1.177	-0.449	-0.384
Responsible_factors_6 Prefer to use solar energy systems as the maintenance is low compared to other renewable energy sources	3.96	0.735	-0.495	0.290
Responsible_factors_7 Prefer to use solar energy systems as it is compatible with the existing electrical systems installed in the Industry	3.96	0.870	-1.261	2.791
Responsible_factors_8 Prefer to use solar energy generation as it has become an affordable power source	4.04	0.870	-0.735	-0.004
Responsible_factors_9 Prefer to use solar energy systems through word of mouth promotion or reference from other industry counterparts	3.68	0.714	-0.039	-0.259
Responsible_factors_10 Prefer Solar energy production as it is less complex when compared with other renewable energy sources	3.79	1.086	-0.774	-0.075
Responsible_factors_11 Prefer to use solar energy as its available throughout the year	3.57	1.056	-0.183	-1.169
Responsible_factors_12 Prefer solar energy to meet the RPO/Green energy commitments set by the Government	3.93	1.106	-1.316	1.323
Responsible_factors_13 Prefer solar energy systems as it can be installed in the factory itself unlike other renewable sources which has to be installed only in certain locations away from the factory	4.01	0.928	-1.385	2.427
Responsible_factors_14 Prefer solar energy generation as it's the only available alternate sources of energy	3.32	1.007	0.189	-1.049

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Table 2- Measurement Model – Responsible and resisting factors influence the adoption of solar technologies by Industrial users in Bengaluru.

Model Fit Summary				
CMIN				
Model	NPAR	CMIN	Degrees of Freedom	CMIN/DF
				(χ2/df)
Default model	119	212.997	123	2.876
Criteria				<3.000
RMR, GFI				
Model	RMR	GFI	AGFI	PGFI
Default model	0.048	0.826		
Criteria	<0.100	>0.80		

Table 3- Structural Model – Responsible and resisting factors influence the adoption of solar technologies by Industrial users in Bengaluru

			Unstd. estimates	Standardised estimates	P values
Adoption_Solar	<---	Resisting	(0.296)	0.112	***
Adoption_Solar	<---	Responsible	0.116	0.083	***

Table 4 –Structural Equation Model – Responsible and resisting factors influence the adoption of solar technologies by Industrial users in Bengaluru

RESEARCH ARTICLE
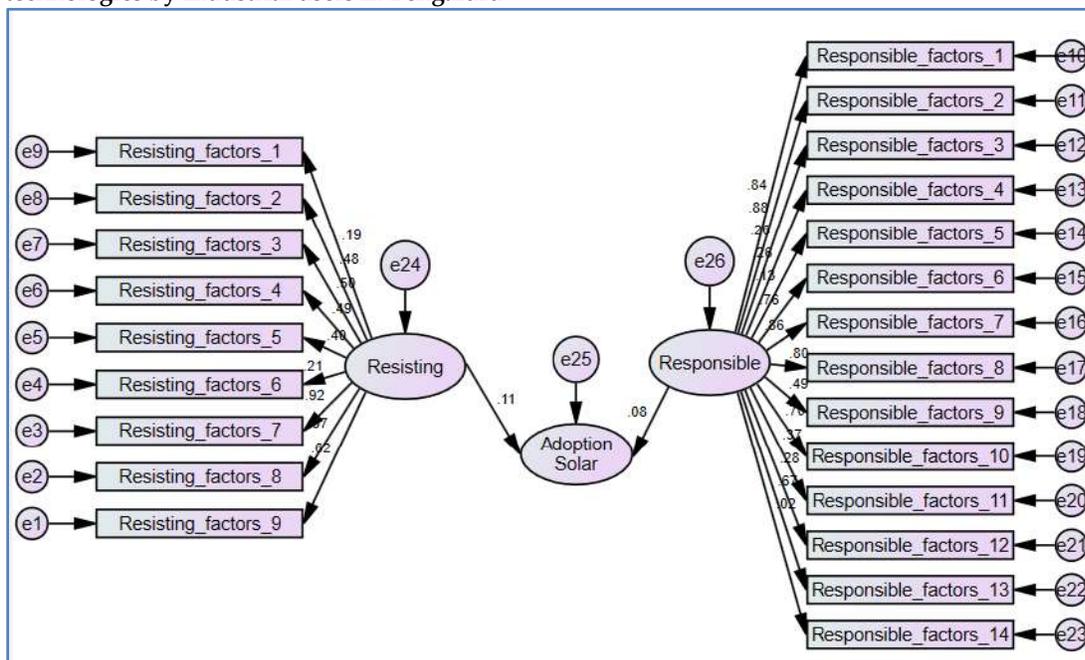
The News Media's War on Truth: How Propaganda Is Shaping Our World

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ABSTRACT

News organizations shape people's perceptions of the world greatly, yet they are also disseminating false information more frequently. In order to draw viewers and increase ratings, news organizations frequently skew their stories to affect people's opinions and prioritize sensationalism over factual truth. Exaggerated, inaccurate, and biased reporting may result from this. Additionally, most news is editorialized to support the agenda or stance of the publisher. Many news organizations are affiliated with a particular political party or ideology, which is a major cause of biased reporting. News channels also exploit people's emotions by broadcasting only sensational stories that evoke emotions like fear, anger, and hatred. This can influence public opinion and persuade people to support the outlet's agenda. In their rush to be the first to report breaking news, press agencies often skip fact-checking and verification, which has led to the spread of misinformation. This is one of the biggest challenges facing society today. Propaganda spread through news outlets is a serious threat to the credibility of journalism and free societies. News organizations have a responsibility to the public to promote ethical journalism, ensure fact-checking, and provide fair news. This study examine the opinions of the public regarding the manipulation of public perception by news channels and journalists and identify alternative news sources that a general literate public may use in place of news channels which are trustworthy, objective and free of any bias or tendency to shape general perceptions, the researcher took over a quantitative method along with the use of cross-sectional survey, by the circulation of a questionnaire to 200 samples comprising college students, educators, medical professionals, lawyers and employees from IT and software firms.

Keywords: Misinformation, Propaganda, News-outlets, Sensationalism, Fact-checking.

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INTRODUCTION

False or erroneous information that is disseminated, frequently with the intention of misleading or controlling people, is referred to as propaganda, misinformation, or false news. Multiple channels, including as websites, social media, email, blogs, radio, television, and others, can be used for this (Anderson, 2021). The media's purported fourth estate role in holding the powerful accountable is largely attributed to their readiness to counteract misinformation, which is what takes us to our worry. The award-winning journalist Robert Fisk provides a clear and accurate explanation of the fourth estate mandate in action when he says that the job of the journalist is "to challenge authority - all authority - especially so when governments and politicians take us to war, when they have decided that they will kill, and others will die"(Foley,S.,2021). Spreading propaganda, misleading information, and misinformation can be greatly aided by social media and traditional media. In addition to validating preexisting attitudes and ideas, they can be utilized to motivate people to take action. Politicians can reach a wide audience through mass media and social media, which also helps spread awareness of other people's viewpoints. In other words, because they may be used to influence people's beliefs and behavior, propaganda, disinformation, and fake news pose a significant threat. Being cognizant of these issues and using discernment when consuming information is crucial. During the Great Depression, propaganda and "alternative facts" became increasingly prevalent worldwide, causing an unparalleled number of casualties. Propagandists from Britain during World War I further obstructed the view of the West for Europeans (Brendon, 2018). There has been a drop in public confidence in the media and its institutions in recent years. With the rise of social media, misinformation and propaganda have become easier to spread. It has consequently led to a decline in public trust in authorities and the media. This is a perilous tendency that could lead to increased polarization and societal instability. Our commitment to accountability and transparency in the media and in government must be reaffirmed.

Public opinion can spread widely over a big geographic area and to a huge number of individuals thanks to the media. Though on a smaller scale, word-of-mouth can serve a similar purpose in locations where social media is prohibited or mass media is not readily available, such as underdeveloped nations or nations with stringent control over print and electronic media. Large gatherings of people around a village radio or community television are commonplace in developing nations, as is the practice of literate persons reading newspapers to those who are illiterate. The influence of public opinion is important because it allows the government to make a number of policy decisions. In a democracy, the people are at the center of government policies and initiatives, and public opinion is vital to determine whether government activities can have the intended effect. The people and the government are able to communicate through the mass media. Its purpose is to supply information to the public so that they may make decisions based on that knowledge. The media's agenda-setting theory is primarily responsible for influencing public opinion (Public Opinion and Role of Media, n.d.). This agenda-setting argument has two parts: first, the media shapes and filters reality before telecasting it; instead of showing it as it is, it poses certain distortions. The public is led to believe that a select few topics are the only significant ones that need to be addressed because, second, the media does not always need to cover everything that is happening in the world. Word-of-mouth within the market or community then disseminates the information even more. A lot of information is disseminated through rumors in nations where the government censors significant news. Therefore, word-of-mouth (or other person-to-person communication channels, like text messaging) becomes the vehicle for underground public opinion in authoritarian or totalitarian countries—despite the fact that these channels are slower and usually involve fewer individuals than in nations with a densely populated and unregulated media network. When news is presented in an exciting and attention-grabbing fashion, even when it isn't true, it's known as sensationalism. News articles that focus on sensationalism frequently aim to arouse strong feelings like dread, rage, or exhilaration.

Sensationalism is a tactic used by many news organizations to draw readers and viewers to their stories, but it may also cause tension and anxiety in some. Exaggerating and overselling news items to attract more viewers is a common practice among several news networks, especially in India. This may cause false and misleading information to be disseminated to the general population. Media sensationalism involves the employment of

particular audio-visual elements, sometimes known as "formal features." Audiences are drawn in because music and certain camera angles immediately impact the human senses. The fast editing pace, voice-over narration, reconstruction of news events, zoom-in camera lens movements, eyewitness camera perspective, soundtrack, and voice-over all contribute to these shocking elements (Wang, 2012). News coverage of "crime, violence, natural disasters, accidents, and fires, along with amusing, heartwarming, shocking, or curious vignettes about people in the area" was considered sensationalism before to the 1980s. Stories about celebrities, crimes, sex, accidents, disasters, and public worries have all been tagged as sensational (Grabe et al., 2001). News reports that "violate a comfortable psychological distance between audience members and their perceptions of events in the physical world" can be classified as sensational because they have the ability to elicit stronger emotional and sensory responses than what is typically deemed appropriate for people to go through. It is difficult to define sensationalism in a way that is both precise and comprehensive because the idea of sensationalism in the news has sparked contentious debates in a number of nations, including Nigeria, the United States, Japan, India, and portions of Europe. News is a construction, packaged by news producers and journalists to advance one kind of interest or another, or one ideology over another. These viewpoints are currently gaining traction, and they must be taken into consideration when discussing the issue of sensationalism, regardless of the motivations behind it or who gets blamed in the blame game. The question of ethics, which is and ought to be the method by which media practitioners determine if a journalistic activity or performance is proper or bad, is more important in all of these cases (Uzuegbunam, 2013). The public's perception of the credibility of Nigerian media outlets and journalists are determined how they are regarded. Without exception, ethics cannot grow up to be an afterthought in the business world. It is the responsibility of media professionals to maintain discipline and avoid devaluing the profession due to the increasing number of interests that are emerging in this dynamic world. We have to maintain our feeling of accountability. Having the title of "watchdogs" nobody watches is already a terrible enough situation.A notable illustration of how the news media may sensationalize news is Republic TV, a well-known Indian news channel. The channel's chief editor, Arnab Goswami, is well-known for his sensationalistic and deceptive reporting. The most well-known fraud in which Goswami and his business have been implicated is the 2020 TRP Manipulation fraud. Thaver (2020) reported that there were allegations in 2020 that certain television broadcasters, such as Republic TV, were manipulating their viewing ratings. The way this was accomplished was by paying low-income individuals to keep Republic TV on even when they weren't watching it. Due to advertisers' willingness to pay more for a wider audience, Republic TV was able to negotiate higher advertising rates. Because it erodes public confidence in the news media, the TRP Manipulation Scam is a severe issue. It is challenging for the public to discern between news that is sensationalized and misrepresented. This may cause some people to base their decisions on false information.

A multifaceted strategy including media companies, journalists, and media consumers is needed to combat media bias. In their reporting, media outlets must place a high priority on impartiality, accuracy, and transparency. They can present a more impartial picture of the world by presenting a variety of viewpoints and encouraging critical thought (Ansh, 2023). Maintaining professional ethics and following strict journalistic standards while avoiding bias and sensationalism is the responsibility of journalists as well. However, media users need to develop their media literacy in order to actively seek out opposing views and critically assess news sources. Through active engagement with other viewpoints and meticulous fact-checking of information, individuals can both reduce and promote the impact of media bias. The way that different news sites covered the Brexit referendum in 2016 was obviously biased by the media. Certain newspapers clearly expressed their opinions on whether the UK should exit or stay in the EU, presenting their cases in an unfair way and leaving out opposing views. Throughout the referendum, voters' decisions were influenced by this skewed reporting, which also shaped public opinion. Unquestionably, media bias shapes people's perceptions by influencing the stories they read and the information they take in. Its effects are felt across society, causing division, aiding in the spread of false information, and undermining societal cohesiveness. The cultivation of an informed populace and the maintenance of a strong democratic foundation require us to actively seek out and acknowledge the existence of prejudice. In the end, a media environment that is governed by the values of openness, truth, and objectivity has the capacity to enable people to develop beliefs that are based on a thorough and fair understanding of the outside world. A video showing numerous local news presenters throughout the US presenting the same message went popular on social media in March 2018. Timothy Burke, the director of

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video for Deadspin, made the film after reading an article from CNN that listed local station anchors who appeared worried about the address. According to Fortin and Bromwich (2018), Burke ascertained that the message's script originated from Sinclair Broadcast Group, the nation's biggest broadcaster, which possesses or runs 193 TV stations. Sinclair is seeking a $3.9 billion deal to buy Tribune Media, a move that is being held up by regulators over antitrust concerns. Burke's video led to prominent criticism of Sinclair, with some commentators calling the company's actions "insidious.

REVIEW OF LITERATURE

The mainstream news media plays a significant role in the dissemination of fake news, even if they cover fake news with an intent to set the record straight and correct the fabricated information. The study Causes and consequences of mainstream media dissemination of fake news: literature review and synthesis (Tsfati et al., 2020) identifies several reasons why mainstream news media cover fake news like some fake news stories carry enormous news values, and mainstream news media feel compelled to cover them. Other news media cover fake news stories, and mainstream news media may feel compelled to cover them as well. Some fake news stories fit the ideological tendencies of mainstream news media. Fake news stories may be designed to fit important criteria of newsworthiness. The study also examines the potential influences of mainstream news coverage of fake news on their audiences. It finds that mainstream news coverage of fake news may lead to audience members internalizing the wrong information or becoming less certain regarding the truth. The study concludes by calling for more research on mainstream news media coverage of fake news and its impact on audiences. It also suggests that journalists should work with academic scholars to develop formats that will enable reporting on, and correcting fake news, without repeating the wrong information.

The Reuters Institute for the Study of Journalism's study, How China utilizes the news media as a weapon in its propaganda war against the West (Kumar, R., 2021), explores China's use of the news media as a propaganda instrument. According to the report, China has been more adept at using the news media to disseminate false information and reshape global perceptions. It illustrates a number of ways in which China uses the news media to further its propaganda: it disseminates conspiracy theories regarding the source of COVID-19, assigns blame to other nations for the coronavirus outbreak, amplifies pro-China content on social media, bans foreign journalists from China, and invests in state-run media worldwide. The impact of China's propaganda on international media coverage is discussed by the researcher. In other nations, it contends, there has been more positive coverage of China as a result of China's efforts to influence the news media. According to the study's conclusion, China poses a major threat to global democracy and free press because it uses the news media as a tool of propaganda. It exhorts media organizations and journalists to continue reporting on China fairly and accurately while also remaining watchful of China's propaganda activities.

The media has grown even more potent in the technological era, with the capacity to sway public opinion and affect governmental regulations. The public's perception of the fight and its support for the war effort are greatly influenced by the media during times of war. But by emphasizing the human cost of conflict and the significance of peaceful resolution, the media may also be utilized to advance peace. Governments and terrorist groups frequently use the media to achieve their own goals, as examined in the study War, Peace and the Media (Askerov, 2020). In an attempt to stifle criticism and advance their own version of reality, governments may attempt to exert influence over the media. In order to propagate misinformation and enlist new members, terrorist groups may use the media. Reporting on conflict can be done in two different ways: as peace journalism and as war journalism. While peace journalism concentrates on the possibility of peace as well as the human cost of conflict, war journalism emphasizes the bloodshed and drama of battle. War-related policies of the state can be supported by the media. For instance, in order to defend military action, governments may utilize the media to paint their opponents as dangerous and barbarous. The study's conclusion makes the case that the media is a potent instrument that may be applied to both

positive and negative ends. It is vital to evaluate the information we take in from the media critically and to be conscious of the ways in which the media is attempting to sway our opinions.

The concept of misinformation lacks historical contextualization and engagement with the history of propaganda. This makes it difficult to understand the problem of misinformation and to develop solutions. The study Propaganda, misinformation, and histories of media techniques forwarded by (Anderson, C. W., 2021) argues that misinformation studies have a de-structured notion of what information does. This is similar to propaganda analysis, but it also has a "radical intolerance" of sociological and Marxist perspectives that could provide a theoretical basis for understanding social influence. The study concludes by arguing that misinformation studies need to do several things to grow like being more conscious of its own history, particularly its historical conceptual predecessors, more deeply interrogating its informational-agentic concept of what pernicious media content does, more openly advancing its normative agenda and take a normative position on what a good information environment would look like. The study also acknowledges that misinformation studies could be funded by powerful state forces in Western society, but that it is up to the scholarly community to decide how they will react to these temptations.

Propaganda can reduce citizens' willingness to protest in two ways: directly influencing their preferences or beliefs about the government, and indirectly by making them think that other citizens are unwilling to protest. The study Propaganda, Presumed Influence, and Collective Protest (Huang & Cruz, 2021) experimentally shows that the indirect mechanism of propaganda is more important in authoritarian societies. According to the study, Chinese internet users think propaganda influences other people's opinions and support for the government more than it does their own. Additionally, they contend that propaganda lessens the likelihood that other citizens will protest, which lessens their own likelihood of doing so. This is true because collective action and risk-taking are necessary for protest in authoritarian systems. Individuals are less inclined to protest themselves if they think that others are not willing to stop. The results of the study show that propaganda might have more of an impact on others than on the individual. The reason behind this is because individuals often fail to recognize the degree to which propaganda has an impact on them. The study's conclusion imply that propagandizing disinformation can be used by authoritarian governments to stifle dissent by dimming the willingness of others to protest.

The way news is obtained and distributed from conflict areas has changed dramatically as a result of social media. It has become more challenging to confirm the veracity and validity of content, even while this has made the media landscape more accessible and diverse. Public opinion and policy are significantly shaped by both old and new media, yet it is now harder for the general public to obtain trustworthy information due to the abundance of news sources. In this era of rapidly evolving technologies, communication specialists must create conflict resolution and management plans. Zahoor and Sadiq (2021) examine how the link between media and armed conflicts has changed in the era of new communication platforms. Their paper, Media and Armed Conflicts: An Overview, covers this transition. It contends that social media sites have developed into indispensable resources for the collection and distribution of news, and that conventional media outlets are increasingly employing them to cover events. The study highlights the growing use of social networking platforms by traditional news organizations to cover conflicts. It then discusses the importance of new technologies in the field of journalism in general and conflict coverage in particular. The paper also discusses the adaptability of digital media as a platform for gathering and dissemination of news primarily produced by the traditional news organizations. The study concludes by arguing that despite social media's growth, traditional news organizations 'role is still pivotal in amplifying different actors' voices in the armed conflicts. The bloggers and activists (citizen journalists), in the conflict zones, still depend on coverage by the traditional news organizations. In this backdrop, access to authentic and credible news probably serves as the biggest challenge. The traditional news organizations and professional journalists can play their role in this regard and authenticate the information being generated from the conflict zones.

The study Propaganda in Journalism, Advertising, and Politics discusses propaganda and its effects on audience attitudes and behavior. It defines propaganda as a way to deliver a message that appeals to the emotions instead of presenting solid evidence to support a point (Calub & Calub, 2022). It is used by governments, advertisers, and

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salespeople to manipulate people into thinking and acting in ways that benefit them. The study argues that propaganda is often used to deceive people rather than persuade them. Propagandists often use new communication technologies to reach increasingly large audiences in order to shape their views. By talking about some of the typical tactics propagandists employ, the researcher wraps up the study. Among these methods is white propaganda, which is propaganda that is not purposefully misleading and comes from a suitably acknowledged source. Black propaganda that presents a deliberately false appearance of friendliness from the sender. Propaganda that is in between white and black in color, or gray. It also covers how propagandists frequently conceal their identities and goals from the public in an effort to divert attention.

Fake news and disinformation are defined in Journalism, Fake News & Disinformation: A Handbook for Journalism Education and Training, along with a discussion of their differences. False information that is intentionally manufactured and spread with the goal of misleading is known as fake news. False or misleading material that is spread without consideration for the source is known as disinformation. This book is an anthology of essays that examine journalism's place in the era of information overload (Ireton & Posetti, 2018). In order to assist people discern between reality and fiction and make educated judgments, the authors contend that journalism is more crucial than ever. The contents also explains the various strategies that journalists can use to counteract false information and fake news, including fact-checking, confirming sources, and fostering media literacy. A variety of tips on how to teach students about false news and disinformation are included in the book's conclusion for journalism instructors and trainers. It is recommended by the authors that instructors and trainers in journalism assist students in comprehending the various forms of fake news and disinformation, as well as the intentions of those who produce and distribute it. The ability to fact-check and validate sources ought to be taught to the pupils. Assist students in developing their media literacy so they can assess the material they are exposed to critically. Urge the media practitioners to become truth-seeking, morally-responsible journalists.

Media Manipulation and Political Lobbying

The act of trying to sway government decisions by people or groups is known as lobbying. There are numerous ways to go about it, such as holding protests, corresponding with lawmakers, and mailing letters. In every political system, lobbying is a frequent. Persuasion is a critical strategy in media discourse, as it helps shape public opinion to support government or non-governmental objectives practice (Chen, 2023). Social media, advertising, and news coverage can all do this. One well-known instance of propaganda or persuasion in the media is the Radia Tapes Scandal. It involved phone discussions between A. Raja, the nation's telecom minister at the time, and political lobbyist Nira Radia, among other Indian journalists, legislators, and businesspeople (India News Desk, 2022). Conversations regarding influence-peddling and corruption were exposed on the tapes, which were released to the media. Investigations into the 2G telecom scam and Radia's previous PR firm were prompted by the crisis. Transcripts of phone calls between political lobbyist Nira Radia and prominent journalists, politicians, and businesspeople were released by OPEN magazine in 2010. The tapes exposed Radia's attempt to use media figures, including as Barkha Dutt of NDTV, to sway A. Raja's appointment as telecom minister (News Bharati, 2022). In addition, Radia attempted to set up deals related to the 2G spectrum for sale. Radia's actions were allegedly documented by 5,851 phone records that the Central Bureau of Investigation (CBI) claims to possess.

Call transcripts of Nira Radia's interactions with UPA officials showed that she campaigned against Dayanidhi Maran's reappointment as Union Minister of Information and Communications. During an interview with journalist Barkha Dutt, Radia stated that sending a message to the Indian National Congress—the party in power at the time—was "not a problem". Dutt further stated that she would speak with senior Congressman Ghulam Nabi Azad. Later, Radia spoke with Ranjan Bhattacharya, who seemed to be serving as a go-between for the Congress (Kumar & Kumar, 2018). Radia also mentioned in the conversation that Airtel CEO Sunil Bharti Mittal had been lobbying against Maran. Dutt has always denied being involved in this incident, saying that it was a case of poor judgment. However, she is still under investigation by the CBI.

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Media Negligence

Barkha Dutt made a serious mistake during the Kargil conflict. It was hoped that she would have learned from this mistake and become more mature, but she made the same mistake again during the Mumbai terror attacks on November 26, 2008. Her negligence put hundreds of civilians in danger. In one of her reports on the attacks, Dutt said that "her sources are on the 19th floor where the terrorists are currently in their murderous frenzy." She did not hesitate to share this important information live, even though it could have put the civilians and security forces at risk. In an interview, Dutt admitted that the media contributed to the risk by failing to exercise restraint during the broadcast. She also admitted that journalists made mistakes during the Mumbai siege. However, she downplayed the situation by claiming that the media was unaware that the terrorists' managers were watching news broadcasts (Saini, 2015). When questioned about her involvement in the attacks by a journalist at Newslaundry, Dutt did not apologize. She also did not acknowledge that she had made a mistake. Instead, she sent a legal notice to the journalist and threatened to remove the post. Blogger Chaitanya Kunte questioned Dutt's journalistic ethics. Dutt responded by sending him a legal letter. In an interview, she said that she did not regret sending the legal notice because the site had accused her of being responsible for the death of a Mumbai terror attack victim.

The Supreme Court of India has ruled that the media's coverage of the 26/11 Mumbai terror attacks was harmful and irresponsible. The court found that the media's reporting helped the terrorists by providing them with real-time information about the security forces' activities and put civilians in danger. Despite this, just a few months after the attacks, journalist Barkha Dutt was awarded the Padma Shri, one of India's highest civilian honours. This is a prime example of media negligence, showing how journalists and news channels sensationalize news with complete disregard for human life and emotions, all in the pursuit of viewership (News Bharati, 2022).

Objective of the Study

The study aimed to identify alternative news sources that a general literate public may use in place of news channels and to understand and examine the opinions of the public regarding the manipulation of public perception by news channels and journalists.

METHODOLOGY

To understand public opinion on how news channels and journalists manipulate public perception and to identify alternative news sources for the general public, the researcher used a quantitative cross-sectional survey and circulated a questionnaire to a specific demographic group of 200 people, including college students, educators, medical professionals, lawyers, and IT and software employees, using Google Forms.

FINDINGS AND DISCUSSION

During the process of data interpretation, figure (fig.1) below represents the first question of the survey questionnaire asked respondents if they think the concept of "media ownership" is appropriate or necessary. The majority of the respondents 82% agreed with the concept of "Media Ownership" while the percentage of people that disagreed is about 16%, while 2% of the respondents were unaware with the concept.

The figure below (Fig.2) represents the respondents that were asked whether they believed political parties have a major influence on news channels and then asked about their opinions about "Media Censorship", 97.6% of the respondents agreed and 2.4% of them disagreed.

The figure (Fig. 3) below represents the mixed responds received from the respondents on being asked about their views on media censorship in which majority of the respondents (67.4%) agreed with the concept of allowing "media censorship and 32.6% of the respondents disagreed with it.

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The figure (Fig.4) below represents the responses from the respondents about the statement that news channels having their own personal propaganda, 87.2% of the respondents agreed and 12.8% of the respondents disagreed with it. The figure (Fig.5) below represents the responses from the respondents for the statement, 'News Channels and Organizations manipulate facts and figures to favour their personal agenda' where majority (83.3%) agreed and 16.7% of the respondents disagreed. The Figure (Fig.6) below represents that 94.1% of the respondents agreed to the statement of scrutinization of Journalists and News Channels for sensationalizing information to boost their ratings, in contrast to the 5.9% of the respondents did not believe and disagreed the statement. The figure (Fig.7) below represents the responses where majority of the respondents (79.2%) of the respondents agreed to the statement that News channels misuse fear in people to endorse personal beliefs and 20.8% of the respondents disagreeing it. (Fig.7) The figure (Fig.8) below represents the responses for the statement 'News Channels only cover certain news that favour their agenda or boost their ratings and neglect other news' to which 82.6% of the respondents agreed finding it appropriate and on the contrary 17.4 % of the respondents disagreed. (Fig.8) The figure (Fig.9) below represents the responses for the statement 'News channels only cover one- side of a news story and tend to neglect the other', to which 68.4% of the respondent's showed agreement and 31.6% of the respondent's showed disagreement. The figure (Fig.10) below represents the responses from individuals' open-ended question stating their personal references for news information. The majority of results were directed towards social media (49%), newspapers (32%), YouTube Videos (10%), blogs (5%) as well as both audio and video podcasts (4%).

The information analyzed above illustrates how news outlets and channels sway public perception by disseminating false information and providing alternatives. It suggests substitute news channels for knowledgeable laypeople to access alternative news sources. It is imperative that these sources are reliable, impartial, devoid of prejudice, and do not shape public perception. Using a cross-section survey approach, 200 people from the fields of education, medicine, IT, and software participated in the study. The results indicated that social media, along with books, YouTube videos, and podcasts, is the most often used alternative news outlet. The survey also revealed that the majority of respondents think political parties have a big influence on news organizations and that most media outlets and journalists are unreliable because political lobbyists can influence them. Information can be manipulated in a number of ways by news organizations and sources to further their goals, sway public opinion, or draw in more readers and viewers. Sensationalism, prejudice, and financial interests are a few of the elements that might result in deception. A minority of respondents also think that credible sources include press conferences, radio, and TED Talks. Some individuals also think that speaking with witnesses or obtaining firsthand recollections might serve as trustworthy sources. This might not always be feasible, though.

CONCLUSION

The study concludes by asserting that finding an unbiased, reliable, and trustworthy news source is essential in today's world. It also suggests that future research can discourse the limitations of the current study by using large small sample size and restricting the population to literate people. According to the study's findings, people frequently believe that journalists and news organizations are biased and manipulative. Most respondents think that news organizations fabricate data and facts to fit their own agendas and to promote their point of view. Additionally, respondents think that news outlets only present one side of a subject and sensationalize information. The people may utilize a variety of substitute news sources in place of news channels, according to the report. The most widely used alternative news sources that the participants could find were blogs, YouTube videos, social media, and books.

The majority of respondents think that news organizations are devious and that they can falsify facts to further their own agendas, according to a study on the influence of news channels and organizations on public opinion. The most widely used alternative news medium, after social media, is YouTube videos, podcasts, books, and books. The results imply that individuals have become increasingly conscious of the possibility of bias and manipulation in the news media. This is probably caused by a number of things, such as the growth of social media, which has facilitated

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people's access to news from a multitude of sources, and the growing mistrust of established institutions. News organizations are also affected by it. In addition to being more thorough in fact-checking their reporting, news organizations should be more open about their funding and sources. Additionally, they must be more conscious of the possibility of bias in the news they cover. The study's conclusions have effects for news consumers as well. News consumers must exercise critical thinking when evaluating the material they read and be mindful of the possibility of prejudice and manipulation. Additionally, people ought to be aware of the sources from which they obtain their news and make an effort to do so from a range of sources.

Everyone has personal prejudices, it's critical to recognize them and prevent them from skewing how we perceive the news. We should also take into account the news's source and whether or not they have a reputation for objectivity and accuracy. When we come across a news article that appears too good to be true or evokes strong feelings in us, we ought to look for additional sources covering the same subject. We should also be skeptical of the evidence offered and mindful of the language employed in the news report. We can be more discerning news consumers and prevent being duped by heeding these suggestions. As a whole, this study offers insightful information on how the public views journalists and news outlets. The results imply that the media sector has to be held to higher standards of responsibility and openness. Additionally, it emphasizes how crucial critical thinking and media literacy are in the digital world.

Recommendations

The study on how news outlets and networks affect public opinion is precise and offers insightful information. The majority of the people in the present sample are academicians, IT and software workers, medical professionals, and university students. It would be intriguing to observe how the results vary among various demographic groups, such as those with varying degrees of political affiliation, income, and education. While lacking in depth, the current study offers a decent summary of the subject. It would be fascinating to find out more about how news outlets and organizations sway public opinion, how news is consumed, and how news consumption itself influences public opinion. Experimental design can be used to investigate how emerging technologies, including artificial intelligence and social media, are influencing public opinion.

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Fig .1 : Media Ownership	Fig.2 : Political parties have a major influence on news channels

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Fig 3 : Do you think media cencorship

Fig.4 : News Channels have their own

Fig .5 : News Channels and Organizations manipulate facts and figures to favour their personal agenda

Fig 6 : Scritomozing of Journalists and News Channels for sensationalizing information to boost their ratings.

Fig. 7 : News channels misuse fear in people to endose personal beliefs.

Fig. 8 : News channels only cover certain news that favour their agenda or boost their

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Fig. 9 : News channels only cover one side of a news story and tend to neglect the other	**Fig.10 : Personal References for news information**

RESEARCH ARTICLE
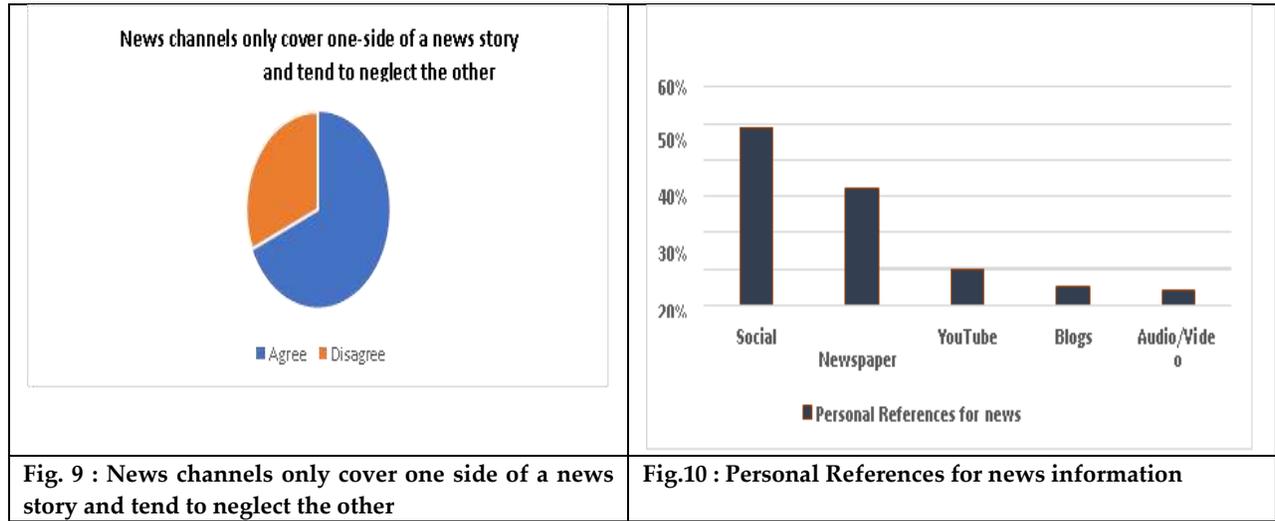
Substantial Archives Clear Up Novel Vistas of Kind and Also Billet Speeches till Now Marginalised With Reference To the Curse of Gandhari by Aditi Banerjee

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ABSTRACT

An observant restating of Mahabharata from Gandhari's point of view is described in *The Curse of Gandhari* by Aditi Banerjee. The author liberates Gandhari from being summarized to an utter representation of her bandage. She builds her consciousness, as Ved Vyasa did, as an experimental female character of huge effectiveness also iron spirit - who, when negotiated, boarded upon a miscellaneous connection with Lord Krishna, in addition became the queen who annoying a deity. The Ramayana and the Mahabharata have crooked out to be an energetic slice of our soul besides our common insensibility. They have drawn attention for several illuminations and re-interpretations oblique categories from poems, plays, ballets, films also books. Realistic clarifications overlap for diverse observations and numerous vocal sounds increasing the outlooks of understanding the landmarks. On one pointer, progressive histories systematized up innovative outlooks of understanding trials while on the other, they also billet voices of up till now ancient history or marginalised typoscripts.

Keywords: Alternative, Blindfolding, Mystery, Noblewoman, Reinterpretation negotiated.

INTRODUCTION

Though Draupadi besides Sita remain adorned round popular present tale, Gandhari, wife of Dhritharastra   in *The Mahabharata*, finds diminutive reference. Aditi Banerjee, in her novel *The Curse of Gandhari*, energies afar the narrow narrative of covering her eyes herself as an action in of devotees to her spouse besides probes unrestricted into her eccentric — as a noblewoman and motherhood. Aditi, the author, an enthusiastic prosecutor in the US, was

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enthralled amidst the intricacy of Gandhari. "She is not a orthodox heroine, but is more complex and ambiguous than Draupadi or Kunti. She has a lot of strength and an iron will power so that even though she is the first to comprehend, when she hears that Kunti has given birth, she is so overwhelmed with emotion that she strikes her belly and she assaults it so hard that this mass of flesh comes out that ends up being her 99 sons also one daughter."

The Supplementary Cross of Blindfolding Has Been A Paradox

Nevertheless, Aditi admired Gandhari's hidden martyr covering of her eyes herself, Gandhari instabilities have been other phase of her personality which is not submissive, passive in addition to yielding. "Gandhari has the ability and voyaged toward expletive of Lord Krishna. Moreover, after the fight remains concluded, besides Gandhari knew her son and would have passed away, since   crook of Gandhari judgment her attention grabs sight prior Yudhisthira's feet and being helpless herself. Yudishtira feet became dark for the reason of she profound sourness, rage also sadness. Gandhari had an incredible power besides determination, self-exploration of her in unfortunate surroundings. Despite Gandhari being unfortunate normal sense, Gandhari being like an aristocrat and have abundance in her nature." Supplementary act of covering her eyes by Gandhari was a mystery explained in unlikely ways. Aditi explains that in one sense it is the act of a promised and reliable mate, a character of *satipratha*. In addition, Gandhari was saddened because wasn't part of the heir of the royal throne that she covered her eyes as an action of suffering grief, Withdrawing herself from human kind and her existence. Multiple absorbing questions have been raised if she had not covered her eyes then she would have been in sight of the spouse and would have been a more observant mom besides would have more influence on her male children. The other feel is that the writer says that in the modern sense, it was a work of noncompliance or outbreak as a queen who could not be in command of the circumstances of her wedding. Gandhari's method of captivating some form of her charge on her existence. The author doesn't think about The *Curse of Gandhari* is being placed as a mythic novel. "For me *The Mahabharata* is not really urban myths. The epic is tangled into our arts and progress. I think it is a true origin substance. But there is at all times some gifted freedom and imaginary in *The Mahabharata.* So, the book is a supposed fiction as the writer has taken this seed of truth from the epic and gone beyond it where it is more speculation."

The author connects the impression that the cut off from the story of her novel was placed subsequently after the warfare, when Gandhari misplaced all her male heirs, "Only her offspring girl abided. After fighting for twelve years, they verve to the wilderness then in the end expire in a fire. What I kept shimmering on is what her last minutes or her last time of her life was like? And did Gandhari, who had gone through so much pain, find serenity or justification at the end of her life?" The author depended on the proceeding of the complete paraphrase of *The Mahabharta.* It was noteworthy for the author to stay true to the example of the soul and personality of Gandhari. But the author has strained to seal in the voids because *The Mahabharata* tells us only a small amount about her and it does not provide any exploitation or calculation. It just grants the facts. So, the author has based on those proofs. It was noteworthy not to lay aside her and make an absolute declaration, because many instances she has been lessened to her blindfold. There is a shared extra distinction besides deepness to Gandhari.

Captivating Variance between Gandhari and Kunti

Talking approximately about the variance amid Gandhari and Kunti connection, Aditi says that in approximately many ways, they instituted themselves in the same circumstances, but unlike, for example, their attachment with Krishna. Their attitude to lifespan and their character has a slice of captivating variances. Kunti tags with the people around her in the jungle besides also takes care of them. So, the author concluded the relationship as a sistership, where they are frenemies. They remain the only unities who could decide what the other had suffered.

The plan to inscribe about Gandhari came out through one of her inscription programs. The author began with a small story about Gandhari; besides that story kept budding and her trainer anticipated that it would crack into a novel. So, the author toiled on it in addition that is how *The Curse of Gandhari* came to be, says Aditi. She marks abundant assemblies too –her wedding and crossing the dawn of rigid caste system, her choice of restorative takes her into the community space of the accommodations at the arena, away from the constrained secluded inland space of the fortress. In her choice of therapeutic, she cutouts fences of space and also contests feminine philosophies of

conflict and valour and offers conflict to male level headedness by spinning to curing. Her further works comprises a tale on the dearness between Shiva and Sati and a sequence on the life of Krishna from Radha's view point. The writer has paid awareness to focus on Gandhari's compensation in addition to trustworthiness, which ended her iconic charisma. We see her infrequent authority, complex opinions, wrinkled passion, besides shattered dreams. We get to decide the lesser-known structures of her personality. The writer doesn't denote Gandhari as an uncovered woman, but one with huge authority.

CONCLUSION

Gandhari being a woman of ultimate dedication. She being a well brought up, well qualified, authorized female of her times. She has been known of her own soundness and also feebleness. Gandhari agreed to her fortune besides attempting to rebuild with-trying to build it in a far better way — as a woman she was questioned by challenging choices-in an awkward phase. Ongoing the epic of Gandhari's failures, Aditi gives us the incident of Draupadi's unveiled life in self-controlled text. Over the time she has been a dim existence in her life besides the life of the Kuru clan, withdrawing the protection of the ritual and also the transparency of the godly. Gandhari can now barely impact her sons, she is condensed to be a voiceless viewer as soon as the menstruating ensemble of Pandavas is drawn to a public gathering and stripped. In her distress in foiling the unqualified violation of dharma, Gandhari is in the illustrious company – Bhishma, Kripa, Dhritarashtra, even Vidura, numerous fraternity heads also the scholars, entirely were a segment of portion in her embarrassment. Only she, in an expressive act by Aditi, where she is dishonoured ever so openly by Draupadi; Yajnaseni addresses only Kunti and sidesteps Gandhari overall beforehand disappearance for refugee. The gunshot hits the house, she being in chaos. Being too little, too late. Here, Aditi's prose is undemonstrative and also impactful, adds to the histrionic effect. Being a mother Gandhari failed, yet, under the stimulus of the author's pen, we are aggravated to deliberate the fact that feasibly Gandhari was frustrating to make the most of a wicked circumstance, possibly Gandhari was trying to prevent the predictable. Duryodhana (Suyodhana) was the well-behaved son only as long as his determination and his tactics were not complained about, it was his intrinsic nature, none could impact it. His brothers were more his brothers then being Gandhari's sons. We get the sense conceivably Duryodhana was obstinate, maybe the battle was predictable.

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RESEARCH ARTICLE

GIG Workers of India : An Analysis

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ABSTRACT

In this paper "The GIG Workers of India - An Analysis" has how Indian Country has witnessed the increase in the Gig Work due to the increase in usage of digital platforms and drastical shift in relations of labour. This paper covers the on Indian economy's employers, employees, freelancers, independent contractors and issues faced by them. This study also covers the technology's impact on labour market changes and schedules of work. This study also highlights the Gig worker's nature, benefits and issues faced by gig workers, role of gig workers in Indian Economy and impact of technology on GIG workers

Keywords: GIG Workers, Technological Impact, Economic Impact, Challenges of GIG Workers

INTRODUCTION

The Indian economy has witnessed the significant transformation in the outlook of employment. In the past 10 years, the economy of India has seen remarkable changes due to digital technology, changes in consumers preferences, changes in labor market etc., This leads to the upspring of newline of workers who are called as "GIG Workers". The "GIG Workers" adopt digital platforms for their resilient labour of short term-term. The study on "GIG Workers of India" is adopted to understand the "GIG Worker" employment opportunities, problems faced by the GIG-workers, impact on labour force on the Indian economy. The topic "GIG Workers" absorbing the attention and contributing to Case-lets for scholars, Governing ruling and for growth of public.

Objectives of the Study
1.   To know the concept of "Gig Workers"
2.   To examine the nature of "GIG work"
3.   To assess the economic impact
4.   To explore technological role.

REVIEW OF LITERATURE

1.   Deepa Panchbhai and Dr. C. M. Tembhurnekar, An Analytical Study of Current Issues and Opportunities face by the Work force Engaged in the GIG Economy of India, Volume No: 38, Issue 26, Jan-March 2023, ISSN 2348-8425. In this paper, the authors have stated that a freelancer economy refers to individuals who participate in work agreements and receive money from outsourcing. These workers can be self-employed, on-call, or online platform workers. They have no boundaries and benefit both employees and companies. The contract workforce is expected to reach 23.5 million in 2029-30, accounting for 6.7% of India's non-farm workforce. India ranks fifth globally in flexible working, according to the ISF 2019 report. The research examines contract work, division, platform, and worker perspectives.

2.   Shajida Abib Kutty and Dr.S.Sundarajan, "Workforce in Gig Economy: A Descriptive Study on Indian Gig Workers", Journal of Management &Entrepreneurship, Special Issue, April 2022, ISSN: 2229-5348. In this paper, the authors have stated that the "GIG Economy" is a liberal market structure where companies hire freelancers for short-term projects and provisional jobs. The shift towards this model has been driven by factors like digitization, which has increased mobile work and remote work opportunities.

3.   Bobby Jacob and Mohsin, "Growth and Challenges of GIG Employees in India","Parikalpana" – "KIIT Journal of Management", Volume: 17(1), June 2021. In this paper, the authors have studied about the how gig economy is booming in India, its potential to significantly change the employment landscape, and the role of gigsters in enhancing their value proposition, focusing on the suitability of gig workers for job requirements. The paper discusses the obstacles of gigsters face, such as the inability to form a union, the absence of long-term economic stability, and safety concerns in the workplace.

4.   Ria Kasliwal[1], "Gender and the Gig Economy: A Qualitative Study of Gig Platforms for Women Workers", "Observer Research Foundation", May 2022, ISBN No: 359- 978-93-90159-03-1. In this paper, the author has stated that India's gig economy has grown rapidly, but women face challenges in pursuing gig work. This study explores the challenges that women workers in "GIG Work" faces, analyzes platform terms of use and privacy policies, identifies gaps in women's inclusion, and offers recommendations.

RESEARCH METHODOLOGY

This paper is purely conceptual nature of study. The data for study is from secondary sources like various articles, journals, articles, websites etc., as per the requirements of the paper.

GIG- Workers

To gain insight into the term "GIG Workers" it is relevant to known working conditions of GIG-Economy in the country. The demographic analysis gives clarity on the features of "GIG Worker" and social and economic origin. Indian country has diversified group of population which consist of younger generation, tech-savvy and including the aged group of people are attracted to the GIG work for earning additional income along with their regular income due to the advancement in digital literacy and abilities. The Indian Country's "GIG-Workers" comprises a heterogeneous population with different age groups, educational level and with different levels. The heterogenous group of population also comprises the group of people who prefer for flexible work from both rural and urban area of Indian Country. The Younger tech-savvy generation who aspires to utilize their digital skills to contributes to the maximum portion of gig workers. Now- a- days we can witness that their good portion of senior people who are into GIG Working for earning additional income and also due to the scarcity of conventional jobs. The Indian economy

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consists of varied range of young tech-savvy people to elderly group of workers who aspires for flexible employment. This group of workforces from both rural and urban areas who has varied range of skills including writers, translators, software developers and also who are ready to work in the service sector like housekeeping, delivery and driving etc., The GIG economy captivates individuals from different economic conditions, control over work schedules and balance of work life. A thorough knowledge of demographic profile is important for framing policies, to implement social protection measures, addressing problems and opportunities and to provide economic security for "GIG Workers" who are of different age groups, sectors and has varied skills.

Nature of GIG-Workers

The GIG Workers are very different from conventional full-time employees due to the various reasons like:

1. **Flexibility:** The "GIG Workers" have a flexibility in the schedule of work, place of work and methods of work. They select their jobs based on flexibility of timings, work mode and other factors. Thus, it is the nature of freedom which is making GIG employment more attractive and appealing.
2. **Short-term Engagement:** The "GIG Workers" prefers for short-term and project based and temporary assignment of job instead of working in a company for a longer duration. They also prefer for taking up different client's projects on ad-hoc basis.
3. **Diversity of Work:** The GIG Workers comprises of different workforce like graphic-designers, ride-hailing services, delivery partners, freelancers, consultancy services.
4. **Unconventional Contractor Status:** The "GIG Workers" are self-employed group or independent group of workers without any benefits like regular employees receives from their employers like provident fund, health care facilities and other perquisites. They are not entitled for any employment safety measures like perquisites facilities.
5. **Digital Platform Interaction:** The digital platforms and application help "GIG Workers" to find jobs, interact with clients and to explore other opportunities.
6. **Difference in Income-Level:**The "GIG Workers" face variation in their income due to unique characteristics. Sometimes they may earn more income and certain times the earning might be less due to fluctuations in the market.
7. **No Job Security:** Compared to other work group who are full time employees working under employers in conventional method the GIG Work force doesn't entitle for job security due to fluctuations in demand in the market.
8. **An Entrepreneurial Mindset:** The "GIG Economy" helps in upbringing entrepreneurial skills for young people due to various opportunities.
9. **Variety of Workforce:** The GIG Workforce comprises of varied range of people with different age, qualifications, skills and socio-economic backgrounds.
10. **Issues of Social Protection:** The GIG Workforce are denied from social protection measures like retirement plans, health insurance, unemployment benefits etc., compared to conventional jobs. This leads to financial stability.

Technology and GIG Economy

Due to the change in technology the organizations are forced to embrace this challenge by adopting the changing environment in order to stay competitive, due to this paradigm shift many jobs have become obsolete and useless. This gave rise to the gig economy many numbers of individual turning into gig work facilitated by digital labour platforms, according to the Boston consulting group report the gig economy has the potential to service up to 90 million jobs in India. This trend is indicative for evolving employment landscape in the country. According to the GOI the gig economy y is offering more employment opportunities more focused on youth seeking flexible work agreements. Many turn to platforms like ola, uber, Swiggy, Zomato, urban company, Porter, Dunzo, Blink it—these platforms categorize themselves as "tech-aggregators, mediators or facilitators.

Different types can be classified based on the nature of their work

- **Ride -hailing drivers:** this people use their vehicles to provide transportation services to the passengers by attaching to the cab aggregators like ola, uber, etc.,.
- **Delivery executives**: Food-delivery services have gained lot of popularity which led to the increased demand for delivery executives
- **Freelancers:** They are self-employed professionals who offer the skill and expertise for the projects.
- **Development of software**: gig workers assist themselves in creation of websites, software solutions and online applications.
- **Digital marketing:** individuals who are specialized in digital marketing which includes social media marketing, search engine optimization, content creation, pay per click advertising who helps in enhancing organization to increase their online presence.
- **Online tutoring and e-learning**: gig workers in India also provide online tutoring and teaching services example for this can be Unacademy, Byjus etc.,
- **Cyber-Security**: gig workers help the companies to shield the online the risk like penetration testing, vulnerability assessment and security consultation.
- In recent times, a lot of emphases is given on the collection and analysis of big data. Big Data, that is the theoretical treatment of information and Digital Intelligence that is technological tools like Artificial Intelligence (AI), Machine Learning, Internet of Things (IoT) are real game-changers.

Economic Contribution by GIG Workers in India:

According to the Niti Ayog report platform-based gig economy as rapidly grown in India. A study report released by NITI Aayog makes an estimate that in 2020-21, 77 lakh workers were engaged in the gig economy. There are about 24 million platform-based gig workers in India as of 2020-21.the gig workforce is expected to expand to 2.35 crore workers by 2029-30. About 47 per cent of the gig work under medium-skilled jobs, about 22 per cent in high skilled and about 31 per cent in low skilled jobs. It is also expected to Create up to 56 million new jobs by 2029 which adds to 1.3% to the GDP. NON-PLATFORM based gig worker creates job about 34 million new jobs by 2029-2030.

Challenges faced by GIG Workers

As gig workers are independent workers few revampcation is necessary in order to protect the interest of the gig workers which are also considered as a concern for gig workers:

1. **Labour laws**: the labour laws currently we have is designed with the view of traditional employment, slight changes are necessary to protect unique need and vulnerability of gig workers.
2. **Social Security**: GIG workers does not get the benefit of traditional employment like health benefits, retirement, regular income
3. Clear definitions are necessary for determine the eligibility for social security.
4. Gender biased working on the gig platform

CONCLUSION

After looking into the opportunities and the expected figures of raise in the gig work force undoubtedly it is gaining popularity in India specially with youth and women workers. According to the international labour organization India is the second largest gig economy in the world. It is changing the landscape of labour in India by offering flexibility but there is a raising complex question about rights, protection, and social inclusion. There is a requirement of regulatory reforms to ensure the fair compensation, social security, to voice their concern. By making the required changes India can have a balance between embracing the gig economy potential to the best advantage and safeguarding the rights and welfare of the workers through greater collaboration between the government, employers, and workers' organizations.

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RESEARCH ARTICLE

Withdrawal of Documents Policy: A Must to Maintain Active Library System

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ABSTRACT

Withdrawal of books or weed out of books from the library and information centre is the most essential exercise of to be carried out at regular intervals. Such activity will be of most useful to develop healthy and feasible collection. The process of weeding out of old, unwanted, unused and mutilated books from the stock will help to procure a book which is of in demand and will make space for the books acquired newly.

Keywords: Collection Management, Withdrawal Policy, MUSTIE model, etc…

INTRODUCTION

The higher education system in India is at transition stage and it is more concentrated to build the strong education system keeping in mind of the global village concept. Since the implementation of National Education Policy 2020 the more emphasis will be on research and library and information centre plays vital role in catering the information need of its users. To meet the ever expanding demand on the information it is exceptional for the library and information centre to update its collection as per the demand and weed out the unwanted things from library at regular intervals. Weed out policy is an essential activity need to be drafted by any library and information centre while constituting its collection management policy to keep its collection up-to-date and remove the unwanted books from the stock. Withdrawal of unused books from the library makes space to acquire useful and updated books to the library and serve the needs of its users. The Buffalo and Erie County Public Library System, New York, USA follows a procedure called MUSTIE Model in its collection management policy to weeding of documents. In United

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States Public Library System a general guidelines called CREW(Continuous Review, Evaluation, and Weeding) method adapted in collection management.

Six general criteria summarized with the acronym **"MUSTIE"** were formed for considering withdrawal of an item from the collection in the CREW method.

MUSTIE stands for

M = Misleading - factually inaccurate
U = Ugly - worn beyond mending or rebinding
S = Superseded - by a new edition of/or by a much better book on the subject
T = Trivial - of no visible literary or scientific merit
I = Irrelevant to the needs and interests of the library's community
E = Elsewhere - the material is easily obtainable from another library

Age and Usage are the two major factors to evaluate the withdrawal of the library documents. The above listed are the major criteria to identify and weed out the documents from the collection. Further the MUSTIE model emphasis on the following factors for consideration into the process of withdrawal of documents are called as "**WORST**";-

W - Worn out - cracked, scratched, grainy, fuzzy, or previously repaired
O - Out of date - dated and/or inaccurate
R - Rarely used
S - Supplied elsewhere
T - Trivial or faddish

The above methods are commonly in use in the western countries public library system to manage the library and information centres effectively. But in indian scenario there is a lapse of such model or standard to weed out the collection, still some suggestions made by the UGC Committee 1957 headed by the Chairmanship of Dr. S.R. Ranganathan published a document on "Development of university and college libraries" in 1965 deliberates on effective library management by framing the guidelines on staffing, budgeting, library collection development, Maintenance of accounts, book selection authority, promotion of reading habits through open access to stacks, norms for loss of books, weed out of unwanted and unserviceable documents, etc….

Later in 2007, the National Knowledge Commission issued guidelines keeping in view of latest ICT application in libraries with regards to collection development, monitoring and evaluation of collection and services recommends to withdrawal of library documents should be a regular process. It is very important for every library to develop a Withdrawal Policy approved by the competent authority to cater effective library service. Based on the suggestions and recommendations made by the different commissions, the following factors are taken into consideration to weed out/withdraw the documents from the library and information centres;-

Factors to be considered for withdrawal/weed-out of books
"Physical condition
The books physical condition is the major factor need to be taken into consideration for withdrawal of the document. It is recommended to weed out badly mutilated or damaged materials from the stock keeping in mind that the same copy could be procured based on its demand".

"Duplicate or multiple copies
Especially in academic libraries the practice of accumulating multiple copies of books are in common use. It is ideal for any library and information centre to withdraw the duplicate copies to make space for the new books. To avoid procuring multiple copies of books, it is recommended to purchase reference books instead of textbooks and inculcate the habit of reading of reference materials among students".

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"Use of e-resources

In view of increasing use of electronic resources through library subscriptions or consortia or open access the use of print is slowly decreasing in higher educational institutions. Thus the duplicate print can be kept aside either in passive collection or even can be weeded out ife-resources are purchased on perpetual (permanent) access basis".

"Currency

The content of the books should be accurate and up-to-date. In this respect it is taken into consideration that, the newly procured books are revised and of updated edition and the older books with same title need to be withdrawn from the stock. The books in the basic sciences such as Mathematics, Physics and Chemistry are need to be retained since the basics never loses its value".

"Usage

Usage is the major criteria to decide the retention or withdraw of the books from the library and information centre. Keeping the circulation statistics and the reports fetched by the library can be the deciding factor to withdraw the material from the stock. The least circulated books and less consulted materials can be recommended to be withdrawn".

"Uniqueness

The library and information centre is recommended to retain the unique titles of the library suppressing the fact of being old, unused and least consulted".

"Format Uselessness

Books or documents which are in obsolete format may be weeded if the content of the book is available elsewhere or if the material is in poor condition".

"Completeness

If library has procured a book that is part of the multi volume set and the library does not have all the set may be weeded out from the stock. Which doesn't fulfils the completeness".

Standard Procedure to Withdraw the Books

Standard procedure to withdraw the books from the library stock revolves majorly on library staff and it comprises the staff and students of the institution.

➤ A Committee comprises of faculty members from all disciplines, members of the library committee and librarian will be formed by the Head of the Institution to identify the documents to be withdrawn from the library stock.
➤ Proper assistance from the library staff to be provided to the committee and the librarian to identify and make list of the documents which are old, out of syllabus, less circulated and multiple copies acquired in same title to propose for withdrawal from the library.
➤ The books purchased for all students under book bank books can be proposed to be withdrawn from the stock if the syllabus is revised.
➤ In such instance in which new policies or rules were incorporate to the content every year e.g. Titles in General Management, Taxation the earlier editions can be proposed for withdrawal.
➤ The physical condition of the document is one major factor considered for withdrawal. Pages torn, mutilated or damaged publications can also be listed for withdrawal.
➤ In streams such as Computers and Information Technology the titles procured earlier were with superseded technologies, software or hardware will also be considered for withdrawal from the library stock.
➤ It is the responsibility of the library staff to produce report with complete details of the document such as Title, Accession Number, Year of Purchase, Price, Number of copies and reason for considered for withdrawal need to be furnished before the Withdrawal Committee members.
➤ The Committee formed by the Head of the institution will inspect the list proposed for withdrawal and examine and recommend that the books listed can be reused in future or can be used for other courses of the institute and

suggest to retain in the library. The publication which never lose its value and content which never gets obsolete such books to be excluded from the withdrawal list.

➢ It is the responsibility of the committee to verify the each document proposed to be withdrawn from the library and no other books such as missing books, books due from students and staff not added in the withdrawal list. Subject experts in the committee need to validate the list proposed for withdrawal is appropriate and can be considered for further process.

➢ The final list recommended by the committee will be presented to the Head of the Institution for necessary approval. The Head of the Institute will have the complete authority to accept or reject the committee recommendations fully or partially by keeping interest of the institute in mind.

➢ Once the Head of the Institute is satisfied with the list, the same will be forwarded to the management to sanction necessary approval to withdraw the documents from the library stock.

➢ After getting proper approval from the management, the library staff will separate the books listed in the withdrawal from library stock and make necessary arrangements to discard them off.

➢ Once the books are withdrawn, the same need to be updated in the accession register and library management software at the appropriate entries to refine search results.

➢ It is also suggested that, the dailies subscribed to libraries such as newspapers, magazines and journals which serves immediate requirement need to be withdrawn at regular intervals to make space for forthcoming issues in the dedicated shelves. Advised to keep atleast last one year issues of magazines and journals before consideration for withdrawal.

➢ The documents withdrawn from the library may be disposed as per the policy of the institute or can be donated to other institution where it is used for some extent.

Advantages of Weed out of books

➢ Active and useful collection management.

➢ Space to newly acquired books.

➢ Weed out of books will provide clear picture of library collection.

➢ Weed out of books will encourage the use of current collection by its users.

➢ The books weeded out can be donated to any other institution which can be utilised for their need to some extent.

➢ In some cases the contents of the books withdrawn from one institution can be of use for other institution. In such cases the books can be reutilised by the needy institution will achieve the goal of procuring book even after its withdrawal.

CONCLUSION

As per the 5th Law of library science Library is a growing organism the library and information centre keep on expanding its collection day by day. Hence it is very essential to weed out the unused, mutilated, unwanted books and materials from the stock at regular intervals. Collection management policy need to be incorporated with weed out policy to regulate the active and useful collection development and meet the need of its users.

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RESEARCH ARTICLE

Influence of Customer Demographics on the Perception of Social Interaction in Shopping Website – with Special Reference to Amazon Services

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ABSTRACT

The current age is greatly impacted by electronic media, and within this framework, websites have a big impact on how online shoppers behave when making purchases. The notion of social presence in the context of e-commerce refers to the extent to which users feel a sense of engagement and connection with other users when interacting on the platform. This study's goal is to examine how consumer demographics affect how social presence is perceived on buying websites, with a focus on Amazon Services. The current study is descriptive in nature and is based on deductive approach, the study is carried out across Bangalore city. The study is limited to the users of online shopping, specifically Amazon services. A convenience sample of 170 online consumers of Amazon website was selected. A well structured questionnaire was prepared by adapting to the previous studies. The items for Social presence- Integrity and benevolence were adopted from previous studies. The statistical method for the study was the ANOVA test since it focuses on understanding perception and anticipation based on demographic characteristics. The results demonstrate how a variety of criteria, including age, gender, education, and employment, affect a person's feeling of social presence on the website, especially when it comes to Amazon services. It is recommended that online websites tailor their user interface and experience to align with the demographic characteristics of their intended audience. Personalized recommendations based on past purchases, a dashboard that can be customized so that customers may choose the areas and hobbies they are interested in, and the ability to switch between other language versions of the website are all suggested enhancements for Amazon services.

Keywords: Customer demographics , Social interaction , Shopping website, Amazon Services.

INTRODUCTION

The concept of social presence applies to the subjective experience of the presence of individuals within the specific context of communication Bickle, J. T., *et al* (2019). This concept comprises the subjective phenomenological encounter of individuals in the presence of one another, as well as the collective perception of unity and connectedness Jiang, C., *ET AL* (2019).Lowenthal, P. R. (2010)propose that the social presence theory asserts that various communication media play a role in establishing a feeling of presence for both parties engaged, hence influencing their interpersonal connections. Based on the theoretical framework , it is posited that various communication technologies, including text messaging and video conferencing, has the capability to cultivate a sense of social presence. This is achieved by allowing users to perceive the other party as genuine and actively engaged in the interaction. Gefen, D., & Straub, D. W. (2004).A positive association exists between the perceived the degree of social presence and the probability of individuals experiencing A feeling of connection and engagement in the process of communication. The concept presented carries substantial consequences for our understanding and application of various communication modalities in both personal and professional settings Chen, J., & Liao, J. (2022).

The phenomenon being examined primarily entailed a sustained interpersonal interaction with either an individual or an organization, extending over a considerable period of time. Trust is a frequently seen phenomenon that is typically cultivated through prolonged interactions, enabling individuals to form reliable anticipations regarding the behaviors of others, be they humans or entities Cui, G., *et al* (2013). One noteworthy aspect of e-commerce is the absence of in-person interactions, which brings an intriguing dimension that will be investigated in the current study. The lack of face-to-face interaction in electronic commerce poses a significant challenge in cultivating trust between vendors and purchasers Lu, B., *et al* . (2016). When faced with a lack of regular face-to-face interactions, individuals are driven to rely on other indicators of reliability, such as ratings and reviews of sellersShen, J. (2012). In light of the e-Commerce sector's ongoing expansion, it is imperative to look into cutting-edge strategies for building and preserving online transaction trust.

This research examines the manner in which customers perceive the social interaction of e-commerce platforms, with a focus on how these perceptions may vary dependent on demographic factors. The researchers obtained data from a heterogeneous sample of participants, encompassing individuals of varying ages, genders, and income brackets. The objective of this study was to ascertain whether there exist any notable disparities in the perception of social interaction among different demographic groups towards e-commerce platforms. The findings of this study will improve understanding of consumer behaviour in the context of online shopping and help companies tailor their platforms to meet the unique needs and preferences of different customer segments. An outline of the study is provided in the first part. The review of the literature is the main topic of the second segment. The third portion contains information on the research methodologies, while the fourth section contains the study's findings. This study's final section offers its limits and areas for future investigation.

REVIEW OF LITERATURE

This study employed a systematic literature review approach to analyze previous scholarly works that were pertinent to the research inquiries under investigation. The articles were sourced from reputed journals and were scrutinized to determine the level of quality exhibited by each study. Elsevier database, Routledge and CRC Press Taylor and Francis database. Emerald Group Publishing database, Springer Nature database and Sage database. Several supplementary articles were acquired from reputable academic databases such as Wiley, Academia, JSTOR, and Guildford Press.

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The review of literature is presented as:

- Cyr, D., *et al* . (2007). When comparing offline buying to online shopping, the latter is often perceived as lacking in human warmth and friendliness due to its impersonal nature, anonymity, automation, and limited face-to-face encounters. Hence, comprehending the intricacies involved in fostering client loyalty in online contexts, commonly referred to as e-Loyalty, is a multifaceted undertaking. This study presents a proposed model for e-Loyalty and applies it to investigate the impact of different levels of social presence in a B2C e-Services environment on e-Loyalty and its underlying factors of perceived utility, trust, and enjoyment. The present work used structural equation modeling approaches to investigate the aforementioned model, with a sample size of 185 participants. Additional study is undertaken to unveil gender disparities pertaining to hedonic factors inside the e-Loyalty model.

- Lu, B., *et al* . (2016). One significant impediment to the expansion of e-commerce is purportedly the absence of human and social factors. The advent of social commerce has the potential to improve this predicament. Social commerce is an emerging phenomenon within the realm of electronic commerce (e-commerce), wherein social technologies are integrated into e-commerce platforms to facilitate the convergence of commercial and social activities. Social commerce is a phenomenon that seeks to restore the social element of buying inside the realm of e-commerce, hence enhancing the level of social interaction in the online environment. This study utilizes the social presence theory as a framework to examine the characteristics of social interaction in online social commerce marketplaces. It introduces a conceptual framework consisting of three social presence factors. It is predicted that these variables have a beneficial influence on trusting beliefs, which subsequently lead to online buying behaviors. The study model is evaluated by analyzing data obtained from a representative e-commerce platform in China. The results of our study indicate that the existence of social variables facilitated by social technologies plays a key role in the establishment of reliable online relationships for exchanging goods or services. This study substantiates the beneficial influence of the social dimension on molding online purchasing behaviors, hence offering theoretical support for the integration of social and commercial activities. This study presents a novel perspective on the field of e-commerce, highlighting the emerging phenomena of social commerce and emphasizing the need for increased attention towards it.

- Weisberg, J., Te'eni, D., & Arman, L. (2011). The act of online purchasing possesses certain characteristics that set it apart from conventional retail practices, notably in terms of its social dynamics. The objective of this study is to examine the correlation between previous online transactions and purchasing intentions, with a focus on the social context as represented by the concepts of social interaction and trust. A cohort consisting of 115 MBA students who were actively employed participated in a study where they engaged in an online shopping experience. However, their progress was halted at the payment stage. Subsequently, these participants were requested to answer a questionnaire that assessed their perceptions of social presence and trust. The findings indicate that prior purchasing behavior is a significant predictor of future purchase intentions. Additionally, trust and social presence play a role in somewhat mediating this relationship. The consideration of social context is crucial in comprehending the impact of prior behavior on subsequent purchasing decisions. Consequently, it is imperative that designs are optimized to augment social presence and foster confidence. Furthermore, it could prove advantageous to closely observe these mediators in order to identify any potential issues. This study elucidates the significant influence of social context on the phenomenon of internet shopping. The present study aims to ascertain the influence of trust mediation and social presence on the relationship between past purchase behavior and future purchasing intentions.

- Ganguly, B., Dash, S., & Cyr, D. (2011). The primary factor contributing to the aversion towards online shopping, as identified by previous experts, is the absence of confidence in online transactions. The primary aim of this research paper is to establish a comprehensive framework for examining the impact of website characteristics on Trust in online travel portals, and subsequently validate this framework through empirical analysis. During the initial stage, a causal model is constructed to identify the relative significance attributed to various website characteristics in generating confidence inside online travel portals. In the subsequent stage, a series of models have been put up, which center on the personal variables of customers, namely demographic and psychographic factors, that serve as moderators in the association between the aforementioned trust antecedents and trust itself. The empirical model provides insights into the relative significance of website elements that contribute to trust in travel portals among customers with varied psychographic and demographic values in India.

- Li, H., Kuo, C., and Rusell, M. G. (1999). The present study introduced and empirically examined a theoretical framework pertaining to the purchasing behavior of consumers in online contexts. The theoretical framework suggests that the online purchasing behavior of consumers is influenced by factors such as demographics, knowledge of online channels, perceptions of the usefulness of these channels, and individual shopping orientations. The data were gathered by a research organization through the implementation of an online survey targeting a sample of 999 individuals who are Internet users residing in the United States. To ensure the reliability and validity of the data, it underwent a process of cross-validation with other comparable nationwide surveys prior to its utilization for model testing. The study's results revealed that several factors, namely education, convenience orientation, experience orientation, channel knowledge, perceived distribution utility, and perceived accessibility, consistently predict the online buying behavior of Internet users. These variables establish if people are regular online shoppers, infrequent online shoppers, or non-online shoppers. The ramifications of the results and possible directions for future research were covered in the debate.

Research Gap

The existing body of research indicates a scarcity of studies examining the influence of demographic characteristics on individuals' experience of social interaction on online shopping websites. The aforementioned research gap is quite significant since demographic variables like age, gender, and income may have an effect on people's experiences with online buying. Understanding how these traits affect how people perceive your social media presence can help marketers and web developers tailor their strategies and platforms to better serve a variety of clientele.. Hence, it is imperative to do additional research in this domain in order to attain a full comprehension of online customer behavior.

RESEARCH METHODS

The current study is descriptive in nature and is based on deductive approach, the study is carried out across Bangalore city. The study is limited to the users of online shopping , specifically Amazon services . A convenience sample of 170 online consumers of Amazon website was selected. A well structured questionnaire was prepared by adapting to the previous studies. The items for Social interaction- Integrity and benevolence were adapted from the study of Gefen, D., & Straub, D. W. (2004).Since the study is based on understanding the perception and expectation based on demographic variables, ANOVA test was used as the statistical technique for the study McHugh, M. L. (2011). To determine whether there are statistically significant differences in means between two or more independent (unrelated) groups, one-way analysis of variance, or ANOVA, is utilised. It is usually used with three or more groups Kim, T. K. (2017). The following assumptions of ANOVA test assumptions are confirmed.

1. It is appropriate to evaluate continuous dependent variables at the interval or ratio level.
2. Two or more categorical, independent categories should be present in an independent variable. An independent-samples t-test is most commonly used for two categorical, independent groups, although a one-way ANOVA can be used for three or more.
3. Observations are independent, meaning there is no relationship between or within groups. Each group must have unique participants, with no repeats.
4. No notable outliers. Outliers are singular data points that deviate from the norm.
5. Dependent variable should be approximately regularly distributed for each independent variable category.
6. Variances must be homogeneous.

The ANOVA test was carried out using the SPSS software. George, D., & Mallery, M. (2003).

RESULTS AND DISCUSSION

Demographic profile of the respondents

The target demographic comprises a predominantly female population, accounting for 53% of the total, while males make up the remaining 47%. Around 40% of the population falls within the age bracket of 18 to 24 years, whereas

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approximately 28% can be categorized as belonging to the age group encompassing the late 30s and early 40s. A subset of the intended recipients has a minority proportion of individuals who are 55 years of age and older. The data concerning the marital status of the target demographic reveals that 42% of respondents are in a married state, whereas the remaining 55% are categorized as unmarried. The remaining portion consists of persons who are either separated or widowed. A small proportion of the participants demonstrate a lack of literacy skills, whilst only 12% have achieved the acquisition of a Secondary School Leaving Certificate (SSLC). The data indicates that a considerable segment of the population, precisely 29%, has attained a graduate degree, while an additional 35% have engaged in postgraduate studies. The significance of education is of utmost importance in understanding the benefits of organic food items and serves as a vital socio-demographic factor within the scope of this research. Regarding occupation, the data indicates that 35% of respondents classified themselves as students, 12% as homemakers, 26% as employees in private enterprises, and 16% as self-employed individuals. The majority of the target population falls between an income range of INR 20,000 to INR 40,000, with 19% earning above INR 40,000.

Item analysis for Social Interaction

The results of the study show that the average scores above 4.00 suggest a strong influence of the social interaction of the shopping website, namely in terms of integrity (mean = 4.12, standard deviation = 0.876) and benevolence (mean = 4.07, standard deviation = 1.100), on the impulsive online customers of essential products. This suggests that consumers place considerable significance on the dependability and standing of the e-commerce platform while participating in impromptu purchases for vital commodities online. The average ratings indicate a significant impact of these factors on the decision-making process and their contribution to the overall satisfaction received from the online shopping experience. The importance of prioritizing the development and maintenance of a strong social interaction that reflects values such as integrity and kindness is significant for businesses, as it enables the recruitment and retention of spontaneous customers.

Testing of Hypothesis

H1 – Demographic factors have a major influence on how social interaction is perceived on buying websites, particularly with regard to Amazon Services. The objective of the hypothesis is to examine the influence of age, gender, qualification, and occupation on perception of social interaction in shopping website – with special reference to Amazon Services. Given that the demographic variables are categorical in character and the social presence – Integrity and Benevolence are continuous in nature, it is deemed most suitable to employ an analysis of variance (ANOVA) test. By employing an analysis of variance (ANOVA) test, it is possible to evaluate the degree to which these variables exert an influence on perception of social interaction, thereby offering useful insights for enhancing customer satisfaction. The table shows the ANOVA Results inform of F statistics and p values. The F statistics indicate the significance of the differences between the groups in the study. A higher F statistic suggests a greater likelihood that the observed differences are not due to chance. On the other hand, the p values offer proof for adopting or rejecting the null hypothesis. When a p value is smaller than the predefined alpha threshold, which is usually set at 0.05, it signifies that the observed differences are statistically significant and unlikely to be the result of chance.

H1	Age	→	Perception of social interaction	Accepted

The perception of social interaction in the website of Amazon services is substantially influenced by age. The measurement of social interaction is based on the attributes of integrity and benevolence. Younger persons exhibit a tendency to sense a heightened degree of social interaction on the website of Amazon, thereby establishing an association with a platform that is perceived as more reliable and compassionate. Conversely, individuals of advanced age may exhibit a more suspicious perspective, wherein they perceive the social presence of the website to be less authentic and lacking in altruistic intentions. The variation in impression may stem from differing levels of familiarity and ease with online platforms across various age cohorts.

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H2	Gender	→	Perception of social interaction	Accepted

The perception of social interaction in the website of Amazon services is substantially influenced by gender. The measurement of social interaction is based on the attributes of integrity and benevolence. The findings of a study examining users' impressions of Amazon's website indicate that gender significantly influences consumers' perception of the platform's social interaction. The investigation assessed the level of social presence by considering two distinct dimensions: integrity and compassion. The findings of the study revealed that male participants had a stronger inclination to identify elevated levels of integrity with the website, whereas female participants reported a heightened perception of compassion. This finding implies that the perception and assessment of the social dimensions of Amazon's online presence are influenced by gender.

H3	Qualification	→	Perception of social interaction	Rejected

The qualification of customers has a notable influence on the perception of social interaction within the website of Amazon services. The measurement of social interaction is based on the attributes of integrity and benevolence. Customers who possess a high level of qualifications and hold a favorable view regarding Amazon's trustworthiness and compassion are more inclined to experience a pronounced sense of social presence when navigating the website. The customers place their trust in the company's actions and have confidence in its adherence to ethical standards, thereby augmenting their overall experience and level of happiness. In contrast, those with lesser levels of educational attainment may possess distinct perspectives of social interaction. This is due to their susceptibility to having their trust and confidence in a company's ethical conduct and goodwill more readily persuaded or undermined. Hence, it is important to comprehend the qualifications of clients in order to efficiently manage and enhance the social interaction on Amazon's platform.

H4	Occupation	→	Perception of social interaction	Accepted

The consumers' occupation has a substantial influence on the perception of social interaction within the Amazon services website. The measurement of social interaction is based on the attributes of integrity and benevolence. Customers employed in professional industries such as law or medicine exhibit a propensity to perceive a heightened degree of integrity in Amazon's online platform, as they place significant importance on trustworthiness and credibility. In contrast, individuals employed in altruistic professions such as social work or teaching tend to exhibit a greater inclination to perceive a sense of kindness. These individuals appreciate the endeavors of companies in terms of social responsibility and community assistance. In general, the occupation of individuals significantly influences their feeling of social interaction, underscoring the significance of customizing online experiences to cater to diverse occupational cohorts.

CONCLUSION

The sense of social interaction on the website, particularly Amazon services, is influenced by various factors such as age, gender, qualifications, and occupation. It is recommended that online websites tailor their user interface and experience to align with the demographic characteristics of their intended audience. For example, it is possible that younger users may exhibit a preference for an interface that is characterized by increased interactivity and visual attractiveness, whereas elderly users may demonstrate a preference for a layout that is simpler and more straightforward to traverse. Furthermore, the customization of website content and language to accommodate diverse educational backgrounds and professional jobs has the potential to augment user engagement and overall pleasure. By comprehending and mitigating these aspects, digital platforms such as Amazon have the potential to cultivate a more individualized and all-encompassing consumer experience. The suggested improvements for Amazon services encompass personalized recommendations derived from prior purchases, a customisable

dashboard enabling users to select their chosen categories and interests, and the provision to move between several language versions of the website. These innovations have the potential to not only boost user happiness but also foster repeat visits and bolster consumer loyalty. In addition, Amazon may contemplate the provision of specialized sections or filters tailored to certain professions or educational backgrounds, so enhancing the convenience for customers in locating products that are pertinent to their specific requirements. In order to consolidate its standing as a prominent e-commerce platform, Amazon may enhance its position by accommodating the varied interests and needs of its user base.

Scope for Further Research

Future research can focus on how personality factors affect the experience of social presence in online shopping websites, given the current study is dependent on demographic variables. Examining how characteristics like neuroticism, extraversion, and openness to new things affect how people perceive their social presence when they purchase online could be one way to do this. In addition, to further understand the intricate relationship between personality and social presence in online buying, future research might examine how various personality traits interact with other elements, like website design and interactivity. Researchers can obtain a more comprehensive grasp of the elements that contribute to a successful online shopping experience by broadening the scope to include personality attributes.

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Table 1 – ANOVA Results for impact of demographic variables on the perception of social interaction in shopping website – with special reference to Amazon Services

		Age		Gender		Qualification		Occupation	
		F statistics	P value	F statistics	P value	F statistics	P value	F statistics	P value
SPI_1	Promises made by shopping website are likely to be reliable	49.32	***	26.948	***	0.621	0.538	17.201	***
SPI_2	I do not doubt the honesty of shopping website	8.559	***	10.286	***	6.466	0.002	15.013	***
SPI_3	I expect that shopping website will keep promises they make	70.969	***	78.159	***	0.019	0.981	88.372	***
SPI_4	I expect that the advice given by shopping website is their best judgment	7.229	***	8.966	***	3.764	0.024	7.903	***
SPB_1	I expect I can count on shopping website to consider how its actions are met	57.669	***	58.287	***	0.549	0.578	47.521	***
SPB_2	I expect that shopping website intentions are benevolent	30.648	***	28.216	***	8.863	***	25.746	***
SPB_3	I expect that shopping website puts customers' interests before their own	17.864	***	14.877	***	23.256	***	7.382	***
SPB_4	I expect that shopping website is well meaning	32.098	***	14.998	***	21.098	***	11.098	***

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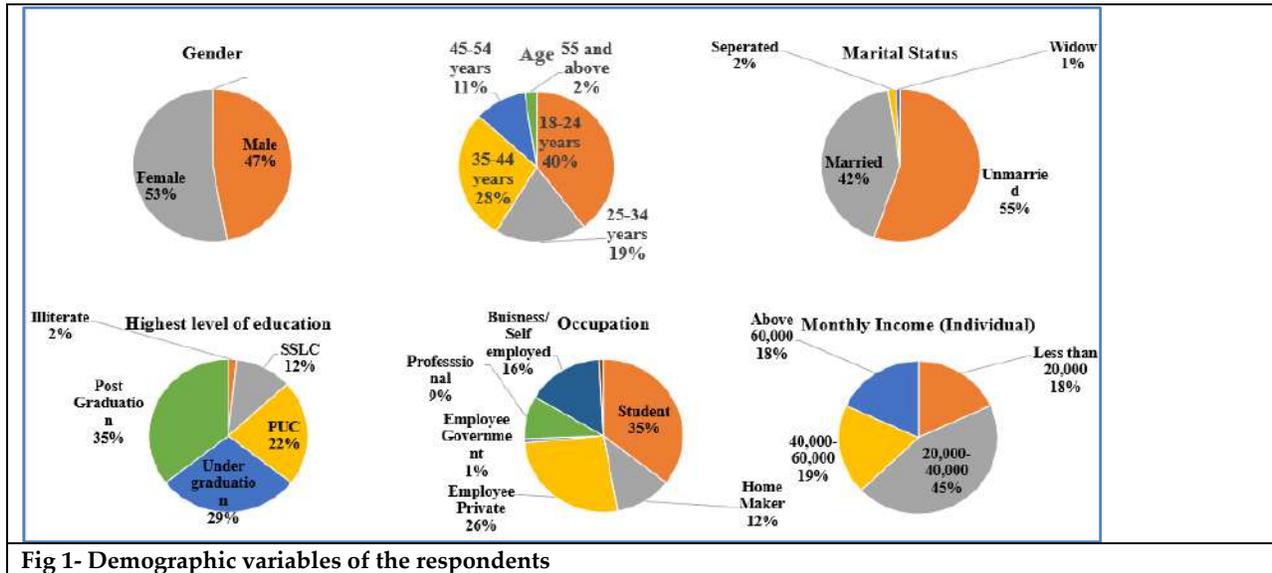
Fig 1- Demographic variables of the respondents

RESEARCH ARTICLE

A Study on Consistency Analysis through Accounting Ratios with Special Reference to Indian Pharma Industries

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ABSTRACT

The biological atrocity that the world underwent during be covid-19 has resulted in new dimensions of human existence in the future, the overwhelming adaptation to the technology has open the door for research and most of the countries wanted to stamp their authority at the time of Covid to prove their pharmaceutical competencies. This has resulted in one sector dominating the overall earnings for almost two to three years with thick size balance sheet. This has promulgated to take this study with an objective of providing the most competent company in the context of India. The tools used to analyze the secondary data based on the published financial statements are management ratios. The rankings of the top 5 pharmaceutical companies are based on the Standard deviation, which significantly prove the strategical force of these companies.

Keywords: Consistency analysis, Financialratios, Covid-19

INTRODUCTION

The drug manufacturing industry in India is apparently showcasing its strong presence in overseas pharmaceuticals market. India is the largest supplier of generic medicines globally, securing a 20% share in worldwide supply by volume, and also caters 62% of global demand for vaccinations (https://www.ibef.org/industry/pharmaceutical-india). India has secured3rdrankworldwide in terms of production by volume and 14th by value (https://www.pib.gov.in/PressReleasePage.aspx?PRID=1821747). India is the only country at the global level with a

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huge number of US-FDA compliant drug manufacturing plantsand has more than 2000 WHO-GMP approved drug manufacturing Plants, 253 European Directorate of Quality Medicines (EDQM) approved plants with modern cutting-edge technology (https://pharmaceuticals.gov.in/pharma-industry-promotion). India's in house drug market turnover have reached Rs 1.4 lakh crores, which is equivalent to $ 20.03 billion in 2019. This is a 9.8% hike from Rs 1.29 lakh crores (US$ 18.12 billion) in 2018. Healthcare services in our country is available in both private and public domains. The annual turnover of the pharmaceutical industry in India in the year 2018-19 was estimated at INR 2.5 lakh crores.   India experienced an increase of 10.72% in pharmaceutical exports in 2018-19, which are evaluated at INR 1.33 lakh cr. As per the Govt of India Budget 2020-21, the allocation to the Department of Pharmaceuticals has been marked at USD 44.47 million (Government of India).

REVIEW OF LITERATURE

Akanksha pawar , Kashish Jalan and Ashim Garg (2016) , IIT Delhi
Examined the impact of financial analysis of pharmaceutical companies in India
Secondary data was collected using secondary sources. The study examined through bar diagrams, some of the important efficiency ratios, solvency ratios and profitability ratios to gauge the financial analysis of prominent 12 Indian pharmaceutical companies for an extensive period covering from 2007 to 2016 using DUPONT 3 POINT ANALYSIS and DUPONT 5 POINT ANALYSIS. The study concluded that TORRENT COMPANY tops in the financial performance and SUN PHARMA is in the last position.

Endri, Desi susanti and 3 others ,(June 2020) , University of Jakarta, Indonesia
Examined the impact of Financial Performance Evaluation : Empirical Evidence of Pharmaceutical companies in Indonesia The study considered secondary data examined the financial performance considering prominent 9 pharmaceutical companies of Indonesia listed in Indonesian stock exchanges during the period from 2014-2018 for their study through line diagrams. The study encompassed the financial performance of considered companies using the ratios of liquidity ratio, activity ratio, solvency ratio, profitability ratio and dupont analysis and have concluded that MERCK SHARP DOHME PHARMA is the best in terms of overall financial performance and financial performance of PIRIDAM PHARMA is pathetic and the company really need to improve its financial performance from all the angles.

Dr Abhishek Daddich(April 2020) Asst. Professor at IIHMR university jaipur,
Examined the impact of   The COVID-19 pandemic on Indian Pharmaceutical industryThe study took into consideration only secondary data and using 2D diagrams,   and revealed how Indian Pharma companies are relying upon Chinese pharma companies on APIs(ACTIVE PHARMACEUTICAL INGREDIENT) for their production of medicine formulations and suggested strategies for promoting Indian API production with numerical data.

Nayyareh Ayati and two others(July 2020) , School of Pharmacy , University of Tehran , Iran Examined the impact of short and long term impacts of COVID- 19 on the pharmaceutical sector of Iran The study mainly aimed at studying pharmaceutical market crisis due to COVID induced pandemic using secondary data both in short and long term and has pin pointed that Short-term impacts of COVID-19 pandemic includes demand changes, regulation revisions, research and development process changes and the shift towards tele-communication and tele-medicine, long term impact includes industry growth slow down, approval delays and ethical dilemmas

Chinmaya Behera and Badari Narayan Rath (March 2021) , Department of liberal arts , IIT Hyderabad Conducted an event study analysis and Examined the impact of The COVID -19 pandemic and Indian pharmaceutical companies-An event study analysis The study considered secondary data and revolves around stock returns of Indian pharmaceutical companies in the wake of COVID-19 pandemic by employing event study methodology. Study indicate that the average returns of the pharmaceutical sector are positive during the COVID-19 phase

although mixed evidence is found at the company level. This fnding is also robust to alternative model specifications.

Deeksha Rani (October 2020) ,Punjab university , Patiala

The study Examined the impact of COVID -19 pandemic on Indian pharmaceutical industries and the study show cased how pharma companies are responding to the challenges posed by pandemic and pin pointed on the unprecedented changes in supply chain management of medicines and business processes especially because of too much dependency on Chinese companies API and outcome of research paper is that Several key representatives from the pharmaceutical industry and NITI Aayog suggests that fostering the approvals of pharmaceutical infrastructure developments, clearance from the environment ministry and providing tax exemptions and subsidies for the development and promotion of the pharmaceutical industry hubs could all benefit the marketby using only secondary data

Dr Sujith Varma (February 2021), HOD, dept of pharmaceuticals , KMCT PHARMACY college , mempara , kerala state

The study show the impact of COVID 19 impact on Indian pharmaceutical industries Study pin pointed using secondary data that how COVID 19 pandemic has turned out to be a boon in disguise to the Indian pharma companies in comparison with a big blow suffered by other line of industries due to slow down of economy because of pandemic induced lockdown. But at the same time researcher points out that in generic market, India is facing high competition from China for the supply of APIs at lower cost. India imports 70 per cent of the API needs from China. This created a lot of hardship to some of the domestic pharmaceutical firms manufacturing certain key APIs. India's health security was under threat due to heavy dependence on China coupled with shortage in supply of key APIs.

Research Gap

The review of literature clearly identifies the gap, which this study seeks to address. Lot of research studies has been undertaken to study the performance and growth of pharmaceutical firms over the period of time. But the impact of the recent pandemic Covid -19 on the financial performance of these firms still needs to be determined. The study further extends to the post pandemic situation of theses industries.

Statement of the Problem

Novel corona virus from November 2019 created serious health hazards among the masses throughout the world leaving no country as an exception. The global mortality rate map consistently maintained an upward index in which India's contribution was also sizeable, it is from this point, to save the Indian citizens from the clutches of death, the Indian pharmaceutical companies geared up to discover the medicine and vaccination for novel corona virus and had to channelize huge funds towards R&D and merchandise of medicines. This particular phenomenon of channelizing huge funds on R&D and magnanimous merchandise of medicines had its own positive and negative implications on the financial wellbeing of pharmaceutical companies. The positive implications on the financial wellbeing of a company can be by and large attributable to a sharp increase in the merchandising of medicines , due to which the revenue of the companies grown substantially and the negative implication on the financial wellbeing by and large attributable to huge expenditures expended by the company on R&D ie towards manufacturing of vaccinations and other allied activities and therefore there raised the need to study the implications of Covid 19 on the financial performance of Indian pharmaceutical companies.

Scope of the Study

The term consistency is a broad concept, the study is restricted to the consistency based on the financial data, the financial analysis covers a spectrum of analysis of which the ratio analysis is considered for the study and of the plethora of ratios only 4 management accounting rations which are considered. The study is based on the published financial data of past 3 years. The study is confined to top 5 Indian pharmaceutical companies, the selection of the top 5 companies is based on its capital employed.

Objective of the Study
1.   To study the consistency based on financial performance of pharmaceutical companies of India.
2.   To derive the suggestions based on the analyzed data.

RESEARCH METHODOLOGY

Paper is descriptive in nature, the study is confined to the published sources of the data in the website of the companies, the pharma companies are taken as the basis for the study and the comparison is made for 5 best companies. The data is analyzed using the accounting ratios and the standard deviation. From the analysis inference is drawn based on the thumb rule of higher the standard deviation, higher the risk and higher rank, lower the standard deviation, lower risk and lower rank. The formula used is as under:

Standard deviation $\sigma = \sqrt{\frac{(X - meanX)^2}{n}}$

Data Analysis and Interpretation
Indian pharmaceutical sector is expected to grow up to US$ 100 billion, while medical equipment's market is expected to grow up to US$ 125 billion by 2025. Export of pharmaceuticals from India stood at US$ 20.70 billion in FY 2019-2020. From the above facts and numbers, we can infer that the Indian drug manufacturing companies have grown magnanimously during the last two decades and are leaving a strong foot print in the global drug market. All Though there are as much as 30 giant pharmaceutical industries in India, only a few of them are magnanimous in terms of their big manufacturing plant establishments, cutting edge technology, turnover, market share, profitability, solvency, higher dividend payout ratios, EPS etc. In this research paper the top 5 pharmaceutical companies based on their profitability and sales has been considered and 5 such top pharmaceutical companies which have listed at the top in terms of their turnover and profitability are SUN PHARMA, AUROBINDO PHARMA, CIPLA PHARMA, LUPIN PHARMA AND Dr REDDY'S LABORATORIES. These companies have a consistent track record of highest turnovers and profits from a decade whose dividend payout ratio is almost a constant and has almost a constant figure of EPS from the last decade.

Inference
The pandemic created by novel corona virus in November 2019 till today, at the global outset did turned out to be a boon for these pharmaceutical companies to multiply their turnover many folds both by in land and overseas sale of drugs. These companies wasted no time in encashing the situation and have grown exponentially despite the other line of industries are badly hit by the COVID induced lockdown. But in this phase of Covid, majority of the companies was able to do well and their profit earning capacity increased and at the same time some of the companies were not able to do well in terms of augmentation in its profit earning. During this time there was an acute need to study the consistency of these top 5 Pharmaceutical companies as how they have maintained consistency with regard to sustenance of net profit, turnover, Return on Equity and Current ratio sustenance.

CONCLUSION AND SUGGESTIONS

COVID-19 was presumed as a century's opportunity for these pharmaceutical industries; as it increases the demand for prescription of medicines, vaccines and medical devices. This can be seen as one of the main short-term effects of COVID-19 epidemic Induced demand. Panic among the COVID patients induces them to buy medicines, medical devices and allied products whether they are in really need of it or not presuming there would be acute shortage of availability and supply of medicines. COVID morbidities also added fuel to the fire which resulted in increased purchase of medicines by the general public and hospitals which resulted in increased demand to be catered by the pharmaceutical companies. The companies have to take necessary measures to ensure the balance of the medicines they produce and sell in the markets. The post covid scenario of the medicines and the stiff competitions from the different companies across the globe cannot be ignored. The overall conclusions based on the facts is positive for the

present scenario and with the growing population around the world the demand for the pharma products if innovated will be on a positive trend.

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Table 1: Table showing the Net Profit Ratio

Sl. No:	Company	POST COVID	POST COVID	DURING COVID	DURING COVID	PRE COVID	PRE COVID
		2022-23	2021-22	2020-21	2019-20	2018-19	2017-18
1	Sun Pharma	8.12%	-0.64%	19.38%	23.16%	6.21%	2.76%
2	Aurobindo	9.61%	12.88%	20.03%	13.69%	12.27%	17.51%
3	Cipla	31.14%	22.59%	18.33%	17.46%	17.10%	14.58%
4	Lupin	3.77%	-1.60%	10.91%	11.25%	6.32%	13.21%
5	Dr Reddys Labs	15.40%	11.26%	11.61%	15.43%	23.32%	11.75%

Source :www.moneycontrol.com

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Table 2. showing the Standard Deviations and ranking of Net Profit of Pharmaceutical companies

Company	Std. deviation of Net Profit Ratio	Ranks
Sun Pharma	9.4054	5
Aurobindo	2.9960	2
Cipla	2.6066	1
Lupin	5.2094	4
Dr Reddys Labs	4.5904	3

Table 3: Table showing total assets turnover ratio

Sl: No:	Company	2022-2023 POST COVID	2021-2022 POST COVID	2020-2021 DURING COVID	2019-2020 DURING COVID	2018-2019 PRE COVID	2017-2018 PRE COVID
1	Sun Pharma	0.51	0.39	24.47	27.31	32.62	32.82
2	Aurobindo	0.55	0.50	0.74	67.91	67.57	65.03
3	Cipla	0.60	0.54	60.53	62.03	67.18	66.62
4	Lupin	0.50	0.33	50.57	53.31	57.67	53.96
5	Dr reddys labs	0.68	0.62	0.65	60.84	65.39	54.73

Source :www.moneycontrol.com

Table 4. showing Standard Deviation and ranking of Total Asset turnover ratio of Pharmaceutical companies

Company	Standard Deviation	Ranking
Sun Pharma	15.23717	1
Aurobindo	36.29488	5
Cipla	32.90164	4
Lupin	27.70073	2
Dr reddys labs	32..85723	3

Table 5. Table showing return on equity (results in units)

Sl: No:	Company	2022-2023 POST COVID	2021-2022 POST COVID	2020-2021 DURING COVID	2019-2020 DURING COVID	2018-2019 PRE COVID	2017-2018 PRE COVID
1	Sun Pharma	7.11	-0.40	14.89	13.16	3.57	1.36
2	Aurobindo	6.84	8.49	15.90	14.37	13.47	18.15
3	Cipla	10.20	13.13	12.38	13.32	11.96	10.40
4	Lupin	2.30	-1.03	6.77	4.16	8.98	8.51
5	Dr Reddys labs	12.76	8.85	12.87	19.33	10.07	4.80

Source :www.moneycontrol.com

Table 6. showing standard deviation and ranking of Return on Equity Ratio

Company	Standard Deviation	Rank
Sun Pharma	6.28736	5
Aurobindo	4.36381	3
Cipla	1.33441	1
Lupin	3.88930	2
Dr Reddys labs	4.87265	4

Table 7. Table showing current ratio (results in units)

Sl: No:	Company	2022-2023 POST COVID	2021-2022 POST COVID	2020-2021 DURING COVID	2019-2020 DURING COVID	2018-2019 PRE COVID	2017-2018 PRE COVID
1	Sun Pharma	1.97	0.96	1.27	1.07	0.84	0.76
2	Aurobindo	1.46	2.35	1.47	1.77	1.55	1.56
3	Cipla	4.95	4.41	3.79	3.45	4.00	2.91
4	Lupin	2.09	2.38	3.72	4.24	4.75	3.73
5	Dr reddys labs	3.11	2.23	1.45	2.42	2.91	1.91

Source :www.moneycontrol.com

Table 8. showing standard deviation and ranking of Current Ratio

Company	Standard Deviation	Rank
Sun Pharma	0.44211	2
Aurobindo	0.34050	1
Cipla	0.71624	4
Lupin	1.04472	5
Dr Reddys labs	0.61859	3

Table 9. Consolidated Table showing the Ranks of Standard Deviations of all the 4 ratios

	Net Profit Ratio	Asset Turnover Ratio	Return on Equity Ratio	Current Ratio
Sun Pharma	5	1	5	2
Aurobindo	2	5	3	1
Cipla	1	4	1	4
Lupin	4	2	2	5
Dr Reddys labs	3	3	4	3
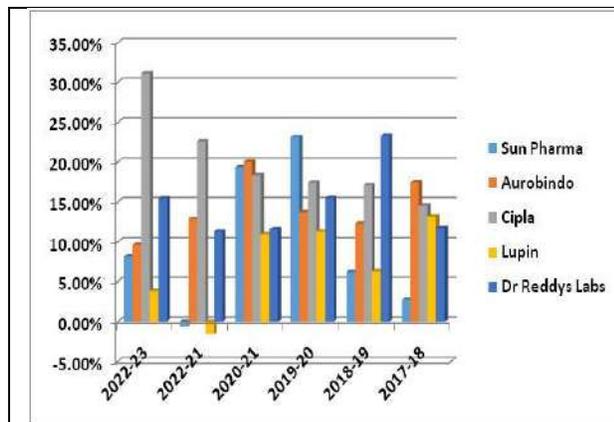
Fig.1 Chart showing the net profit of the companies
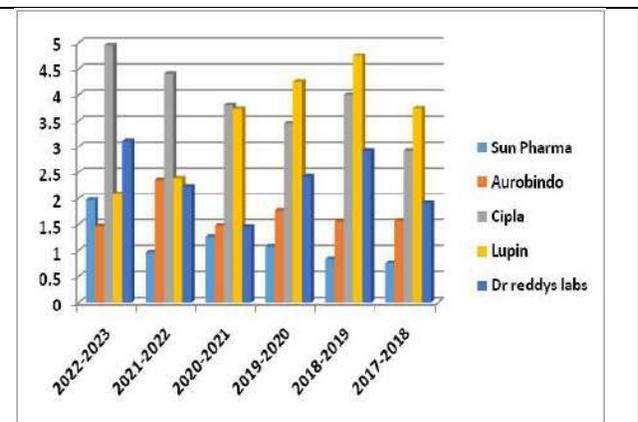
Fig.2 Chart showing asset turnover ratios
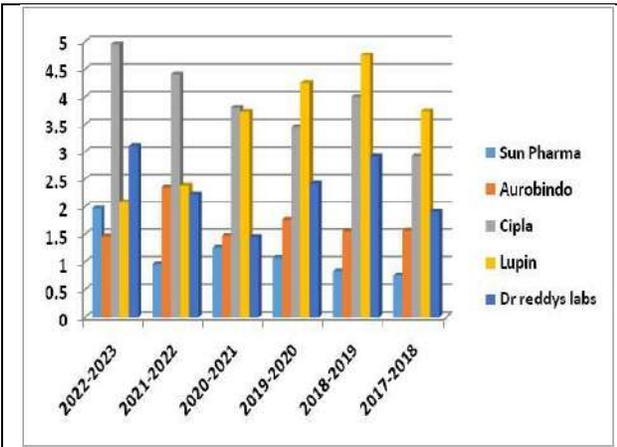
Fig.3 chart showing return on equity of companies	**Fig.4 Chart showing the current ratios of the companies**
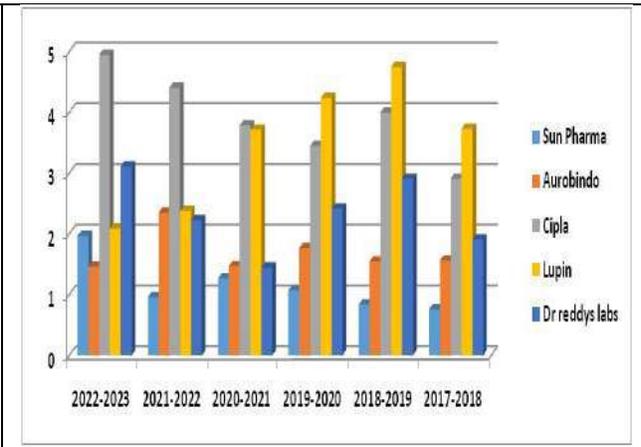
RESEARCH ARTICLE

A Study on the Customer Behaviour influenced by Social Media Marketing

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ABSTRACT

Fifty-one per cent of individuals are using social media more frequently in 2021 than in 2011. This is notably true for platforms like Facebook, Twitter, WhatsApp, and Instagram. Businesses must comprehend how social media users act and what motivates them to buy things. As a final goal, client pleasure is where all marketing efforts converge. What happened in the preceding two years set the stage for this development. Customers rely heavily on social networks to counteract, involve, and control the effects of social isolation and remote work. Social media, often known as digital media, is a subfield of communication studies distinguished by its focus on the intersection of technology and user experience. Marketers can carry out digital campaigns more effectively thanks to cloud computing, data management, and automation developments. This article will explore how social media influences consumers' actions and what those changes represent for a brand's social strategy.

Keywords: Lifestyle, Emotion, Attitude, Household, Global Market.

INTRODUCTION

The media's expanding clout has impacted customers in India, creating more opportunities for goods that meet their needs. The social networking platform facilitated communication between the two parties. Educating and interacting with brands comes at a far more convenient pace for customers. Marketers can now hone in on each customer's specific concerns and respond accordingly. The way customers live their lives is shifting as a result. The relationship between the company and the client has gotten a boost from social media. Customers can learn more about a company's core beliefs, current offerings, and approach to customer service by exploring the brands' social media presence. Individuals, corporations, and brand marketers have all found the social media industry welcoming and

straightforward. The tactics they employ additionally range widely. Some people believe B2C (Business-to-consumer) social media marketing is about establishing connections. In contrast, others hold that it is more about reaching consumers at the right time in the product lifecycle and in the right market.

Customer Behaviour

A historical perspective reveals striking similarities between social media marketing and "Word of Mouth" marketing, which Kozinets *et al*. (2010) define as "The international influence of consumer-to-consumer communication by professional marketing strategies." Similar to other forms of marketing, word-of-mouth promotion has developed over time. Customers used to go to physical stores to buy goods they planned to order online before the advent of social media. Customers can now complete their purchases in less time than it takes to send a tweet. And they want the same level of service from the seller or marketer even after the product has been purchased, in the form of after-sale support. Advertising on social media and other digital platforms has simplified the buying process for consumers. Customers can now shop from anywhere in the world, not just within their own country, thanks to the expansion of e-commerce, in a way that influences either the customer's ability to pay or his decision to buy the product. But what does consumer behaviour entail regarding how customers analyse the market and make decisions? Customers in the modern era are regular people who are only emotionally invested in a product or service if they are swayed on every level (both internally and outside). Influences within the consumer's control include things like their financial situation, personal preferences, social circle, and ability to purchase the goods. Price, brand, quality, quantity, and other external variables are explored. What, when, how, and where of a customer's purchase choice matters. The primary duty of any marketer is to study and comprehend the psyche of their target demographic.

Objectives
1. To understand the concept of consumer behaviour.
2. To study the influence of customer behaviour through advertisement.
3. Factors determining the lifestyle of the consumer.
4. To study the significance of the positive effect of social media.

REVIEW OF LITERATURE

People who buy and use the goods and services on sale are known as consumers. Purchasing patterns among consumers can take time to decipher. The transparency and clarity of information have significantly impacted the dynamic process. Therefore, looking at what factors prevent interested parties from becoming buyers or cause current purchasers to hesitate before making a repeat purchase is essential. As a result, the consumer decision-making process reveals important characteristics of individual consumption behaviour. As reported by Sternthal and Craig (1982) "Social Media Ads and the Impact on Consumer Intention to Buy," by Sriram K V, Namitha KP, and Girish B Kamath. The way people feel about commercials is crucial to their effectiveness. Previous research has sought to identify what factors lead to favourable customer views of internet advertising, and this correlation has been confirmed by subsequent studies (Nasir *et al*., Citation 2021). This result demonstrated a significant positive relationship between online advertising and how consumers felt about it. It was also shown that all of the sub-dimensions of customer perception positively and substantially affected internet advertising and its dimensions (Haur *et al*., Citation2017). Persuasion is at the heart of advertising. To make an effective ad on social media, it is essential to understand what features of an ad can persuade a user (Ahmad *et al*., Citation2019; Lee & Hong, Citation2016). Consumers' attitudes and preferences regarding a particular brand of washing machines in Udumalpet were studied by Suganthi.V. and Mohan S. (2014). Sixty participants were surveyed using a simple random selection technique. Quantitative evaluation Chi-square tests of association were run on the data, and the results showed no correlation between the respondent's age, education level, marital status, or income and their level of satisfaction with the product. Consumer behaviour is affected by social media marketing, according to Anvi Jain and Preeti. Social media marketing aims to increase sales by educating and entertaining consumers so that they feel

more inclined to make a purchase. Brand loyalty and increased purchase intent are two beneficial results of customer interaction. Long-term success depends on the quality of the relationships built with customers, which directly results from brand loyalty. Kim and Ko (2012) found this to be the case. By utilising channels such as online communities, interaction, content sharing, accessibility, and credibility, social media marketing aids in establishing and maintaining fruitful relationships with target audiences. Brand value is significantly affected by these social media advertising tools. (As' ad, Alhadid, 2014) Customers' purchase, loyalty, and involvement intentions can all be affected by the quality of the relationships they have with a company, which is why Wibowo *et al.*, 2021 looked at both SMMA and CE to gauge that quality. Their findings suggest that SMMA and CE each have a substantial role in shaping the quality of romantic partnerships. They have also stressed the significance of using the appropriate marketing content on SNS to obtain long-term business success. Their research proved the importance of excellent relationships by showing that consumers are less likely to buy competing products if the marketing manager assists them in identifying with the company's brand culture.

Suggestions

1. When purchasing, consumers should ensure that the product has been tested for quality and reliability and has been officially certified.
2. To keep consumers interested, businesses must consistently introduce novel goods and services.
3. Customer service and support that ends up convincing buyers.
4. maintaining the product's reputation for quality, quantity, price, and dependability.

CONCLUSION

According to the evaluations above, you should ensure that your Price, Features, and Payment choices are safe. Discounts, seasonal offerings, holiday sales, and product quality all have a role in determining whether or not a customer would make a purchase. Because of the dynamic nature of social media, social proof is becoming an increasingly important part of consumers' decision-making processes. 51% of consumers say they consult social media evaluations before purchasing. One or two unhappy reviewers can turn off a potential buyer. The most expensive television commercial can't compete with the free resources provided by social media. Consumers voice their opinions about brands and services on social media and review sites. Customers are more likely to trust reviews written by those who have used the product or worked with the company in question in the past. Marketing on social media is having a beneficial effect on consumers since it makes it easier for them to find what they're looking for and saves them time and money in the process. As a result, consumers' daily routines are shifting as they have access to products worldwide and enjoy lower pricing than ever before. The costs of various goods can be compared. Social media marketing lets businesses reach and interact with their target audience. Anytime, anywhere, the client can access the supplier's website and communicate with them.

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RESEARCH ARTICLE

A Study on Customers Perception and Preference towards Departmental Stores

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ABSTRACT

Retail and Wholesale: the former is the trade of goods and services to end users and latter is trade to retailers or institutional customers. Retailers purchases goods from either manufacturer or from wholesaler in large numbers and sells the same in small quantities to end users for a profit margin. In the chain of distribution from manufactures to end users, retailers is the last link who sells goods to final users. The objective of this research is to study customer's insight and preference towards Departmental Stores.

Keywords: Customers, Perception, Preference, Retailers

INTRODUCTION

Store in common is known as a place where inventories are stored. A Departmental Store is a retail outlet which offers various categories of products to consumers. The main motto of a departmental store is to provide wide variety of goods under different product categories at a single place and also to provide qualitative goods and services to their customers. The concept was first started in France Department stores were started with the main intention of providing products to customers at a single place rather than them visiting multiple stores.It has multiple departments based on different types of goods sold. Products include household items, groceries, packed food, cutlery, cosmetics, medicines, clothes, toys, electronics, furniture and much more. Presently Departmental stores are focused towards offering personal shopping experience to their customers for which they are also expanding their presence in online to make shopping easier for their customers.

REVIEW OF LITERATURE

P.Jayanthi, C. V.(2018),The article studied the customers shopping behavior and was objected to check the reasons for departmental stores preference of customers. The author suggested that departmental stores must increase their sales customer to minimize the waiting time and they must also allow sufficient parking facilities. Dr. R.Venkatesh, D. Sripriya (2016),In this paper, the authors study factors that influence the customers towards purchase of household articles in a particular town and their needs at the venue of purchase. The authors have opined that the customers would like to have the physical experience of touch and feel of the product before they purchase and customers are satisfied and they prefer departmental stores that other stores. K. Jegan, D.K.(2016), The article studied the perception of consumers to purchase from different retails sectors and also the factors that effects such purchase. The authors have concluded that Departmental stores are at advantage compared to other retail sectors in terms of locational factors, cost structure, customer acquaintance.

M R Chandrasekhar, S.D.(2021), : In this paper, the authors have studied customers opinion on various factors considered for departmental store. The authors have opined that the departmental stores must intensively work on advertising their stores to reach large numbers of customers. The authors have also given suggestions to increase their sales. Ms N Sasikala, M. R.(2012),: The authors have studied the demographic profile of respondents and their preference and perception on the retail shopping. The findings of the paper exhibit that most of the customers were females and suggests that the stores must sell at reasonable price to attract their customers. M Nithyapriya, H. G.(2016), : The study recognized the profile of customers and determine buying behaviour of consumers in the city Coimbatore. The authors have suggested retailers to continuously review the customers satisfaction level and make efforts to improve condition. The article has collected the data from primary source.

Mr.S. Venkatachalapathy, M.A.(2021), : This paper studies the satisfaction level of consumers on departmental stores and discover the problems usually confronted at departmental stores. The results shows that most of the customers belonged to middle age and they spent their time once in month. P. Annal Lourdhu Regina, R.I.(2019), : The paper studies customer's opinion and ideas on various aspect like price, quality and services provided by departmental stores. It also checks the after sales services given by the stores. The authors have also studied the problems faced by the customers. The findings of the study shows that majority of customers were satisfied with the services.

Objectives of the Study
- The study customer's insight and preference towards Departmental Stores
- To investigate the factors that the customers consider to purchase household items from departmental stores.
- To recognise the consumers thoughts and viewpoint about the price, quality and services provided by the departmental stores.

Need of the Study
- To overview the exploration of Departmental store.
- The main aphorism of this research is to know the customers preference towards departmental stores.
- To explore briefly towards departmental store in day to day life.
- To get to know the purchasing behavior in departmental stores by the customers.

RESEARCH METHODOLOGY

The current study is based on primary data. The data required is been collected through questionnaire from the customers in view to study the customer's preference and perception as regards to departmental stores. Data required for the study has been retrieved from 106 respondents. The questionnaire contains question like social profile, shopping behavior etc. Also the respondents include both male and female.

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Data Analysis and Interpretation

The data collected is represented in the form of pie chart. A brief analysis is done and interpretation is given as follows:

Interpretation

As per above the figure 1, it can be observed that among all the respondents more than 61.3% respondents are female. And 37.7% of them are male respondents.

Interpretation

The data was collected from various age groups. From the above figure 2 it is concluded that more than 75.5% of the respondents belongs to the age group of 18-30, 17% of them belongs to the age group of 31-50 and 7.5% of them belongs to the below 18 category.

Interpretation

per figure 3 we can see that the respondent income varies from each other. More than 44.9% of them earn the income of below 25000. 29.6% of the respondents earn the income of RS 25000-50000. 17.3% of the respondent earns the income of above 75000. And only 8.2% of the respondent earns the income of Rs 50000-75000.

Interpretation

per figure 4 the data says the qualification of the respondents varies from one to other. More than 60.4% of them are undergraduates. 26.4% of the respondents qualified as post graduate. And 13.2% of the respondents are qualified as PU.

Interpretation

The data collected from the respondent are shown in the above figure 5. More than 33.3% of them visit the departmental store on weekly basis. 24.8% of them visit the departmental store of monthly basis. 17.1% of the respondent visits the departmental store rarely. 15.2% of them visit the departmental store daily. And 9.5% of them visits the departmental store monthly twice.

Interpretation

per figure 6 we can say that 37.1% of them gave ratings of 3 out of 5 which means they are little satisfied. 29.5% of them gave the rating of 4 out of 5 which means they are satisfied very good rather than 3 out of 5. And there is a tie between the ranking of 2 and 5, which means some respondents are satisfied extremely and some or not.

Interpretation

per figure 7 displayed the customer expectation towards departmental stores are as follows. More than 60.4% of them expect to provide offers and discounts. 38.7% of them expect to be available or opened 24*7. 33% of them expect to have door to door delivery option. And 29.2% of the respondent expects to provide parking facility in the departmental stores.

Interpretation

As per Fig 8, the data collected from the respondent says that 66% of them choose the factor of quality of products to be provided. 39.6% of them choose the factor of fair price to be allotted while purchasing. 32.1% of them choose the factor of wide range of products to be available in the departmental stores. 30.2% of them choose the factor of customer service when the products have been purchased. And 28.3% of them expect or choose the factor of fair value.

Interpretation

As per Fig 9, the data collected from the respondent says that 43.4% of them face the problems of waiting for longer time. 36.8% of them face the challenges of crowded aisles. 34% of them face the challenges of inadequate assistance from the staff. 33% of them face the challenge of stock items. 23.6% of them face the challenge of confusing store layout.

Interpretation

The data collected from the respondents in the above figure 10 says that more than 60.7% of them have not faced any issues with the behavior or service rendered by the departmental store staff. And 39.3% of them states that they have faced issues with the behavior or service of the departmental store staff.

Interpretation

As per Fig 11, the data collected from the respondent says that the reasons behind visiting departmental store are for many purposes. 57.9% of them visit the store for groceries. 50.5% of them visit for clothing and fashion. 32.7% of

them visit electronics. 31.8% of them visit for beauty and cosmetics. 23.4% of them visit the departmental store for furniture and home decor. And 19.6% of them visit the departmental stores for the purpose of toys and games.

Findings of the Study

- The study says that customers prefer to visit the departmental store and expect a wide range of choices has to be provided.
- More than 75.5 percent of them belong to the age group of 18-30.
- More than 61.3% of the respondents are females and whereas 37.7% of them are male respondent.
- More than 37.7% of them are slightly satisfied the departmental store.
- 60.7% of the respondents have not faced any kind of issues with the departmental store staff also 39.3% of them have faced issues with the departmental store staff.
- Majority of the respondent income are below 25000.

CONCLUSION

The departmental store is convenient for the customers and they expect it to be available 24*7, also to render customer services, and make offers and discounts for the products they have purchased. Also the customer expect to charge a fair value for the products they have been purchased.

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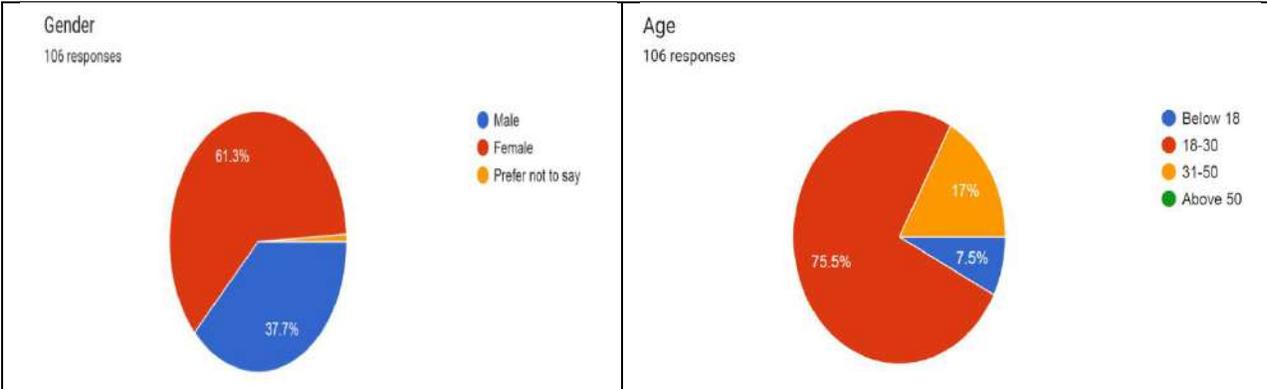
Fig 1: On the basis of gender

Fig 2: On the basis of Age

Fig 3: On the basis of Income

Fig 4: On the basis of Qualification
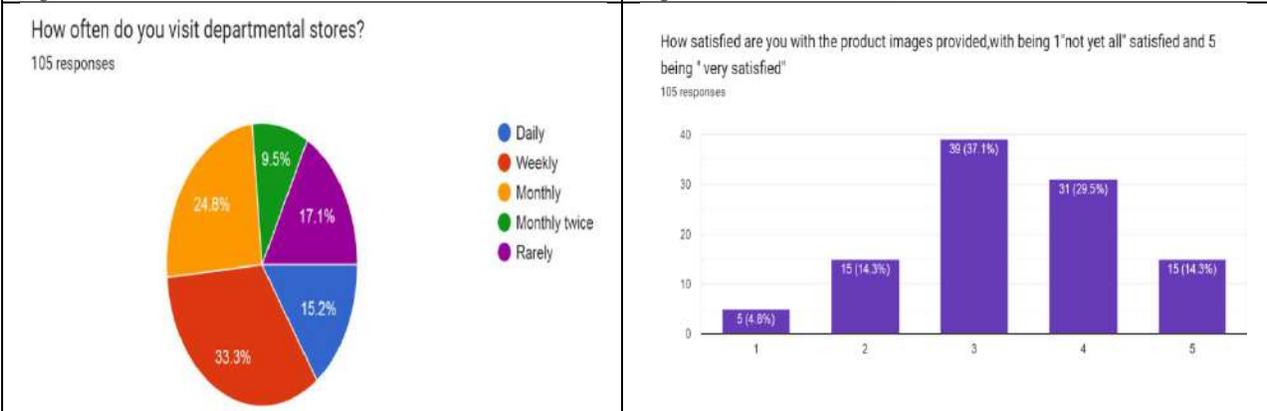
Fig 5: On the basis of how often they visit departmental store

Fig 6: On the basis of satisfied with the products
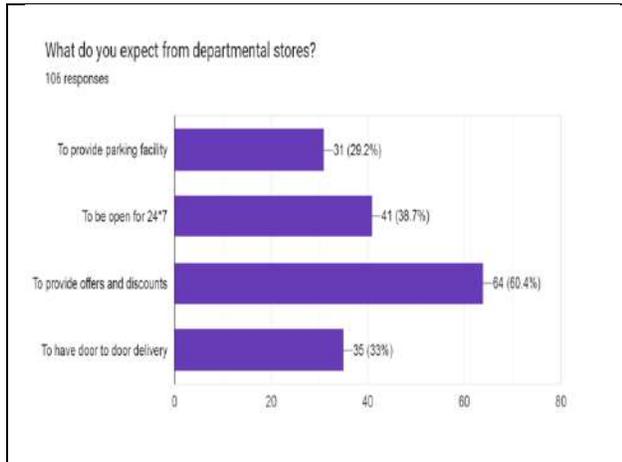
Fig 7: On the basis of expectation of customers towards departmental stores
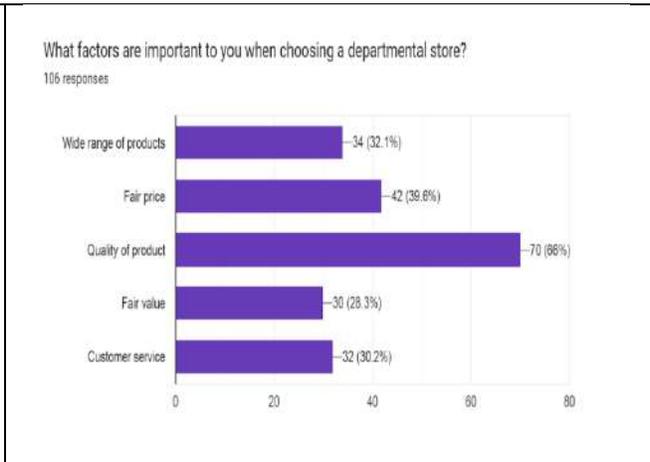
Fig 8: On the basis of factors to choose departmental stores
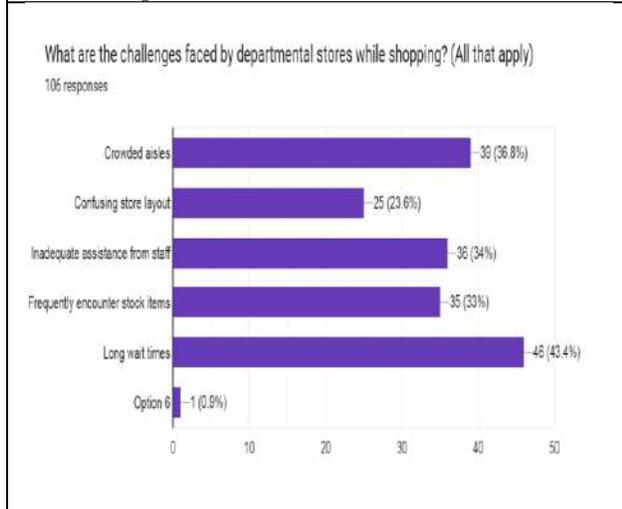
Fig 9: On the basis of challenges faced by departmental stores
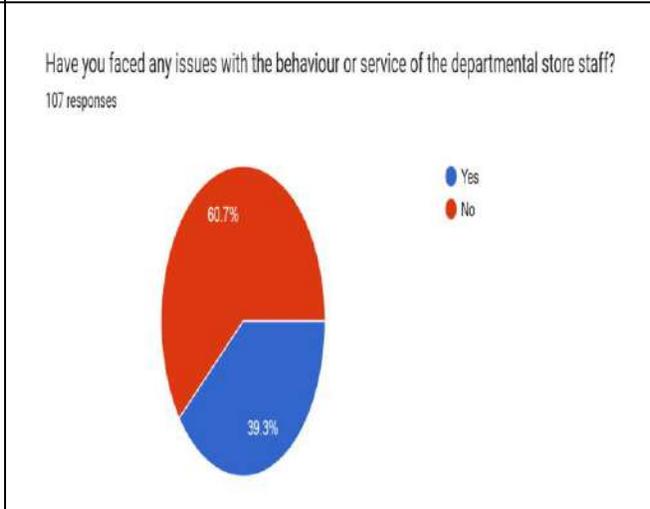
Fig 10: On the basis of faced any issues with the behavior or services

What are your reasons for visiting a departmental store?(Check all that apply)

107 responses
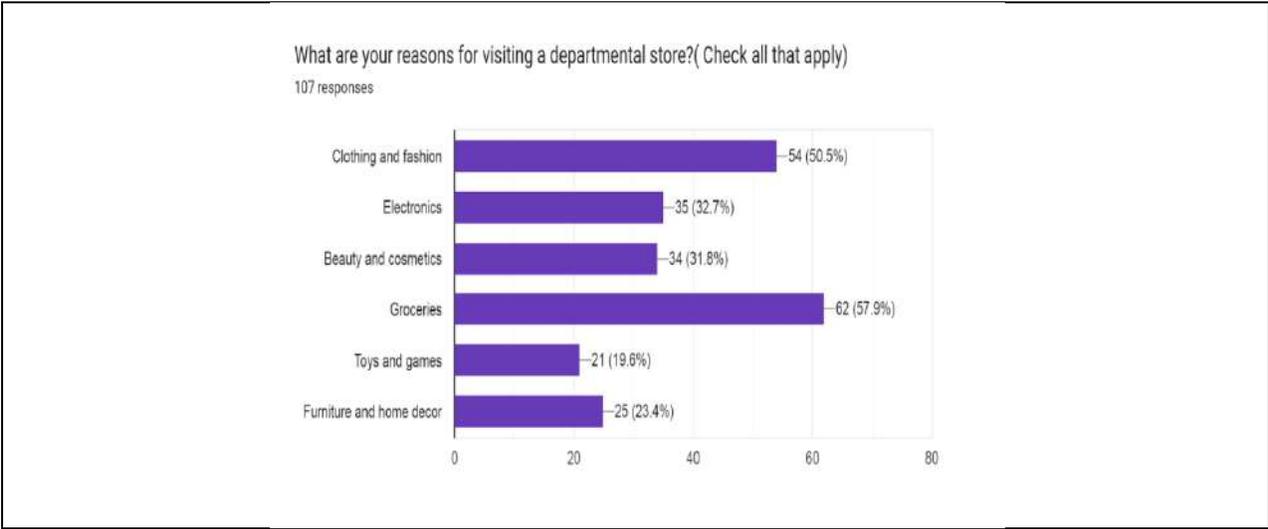
Fig 11: On the basis of reasons for visiting departmental stores

RESEARCH ARTICLE

Combatting Intellectual Property Infringements in E-Commerce Social Engineering Frauds through Cyber Crime Investigation

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ABSTRACT

This research paper describes a cybercrime investigation on e-commerce social engineering fraud, focusing on intellectual property (IP) infringements that happen from data exfiltration, data breaches, and trade secret exfiltration, which in turn have a direct impact on trademark infringements, brand infringements, and different modes of IP damages. Advancing an e-crime investigation procedure and framework to protect IP assets can be made possible by constructing different approaches like a systematic approach, an analytical approach, an audit approach, data protection impact assessment, and a historical evidence collection approach for reactive crimes. Constructing a proactive cybercrime-hunting approach can help to remediate IP violations. The advanced legal sciences modules incorporate a step-by-step process identification of the evidence, collecting, preservation, safeguarding, examination, documentation, and presentation. Measurable scientific methods can improve computerized verification and optimize complex examinations. Case studies on e-crime in e-commerce, which has the potential to damage IP assets through social engineering fraud (SEF) reveal the different modes of cybercrime and their possible effects on individuals and corporations. The universal characteristics of e-crime make collecting digital evidence for e-commerce crimes a challenging task. Digital evidence collection has various challenges, including admissibility, rapid technological improvements, and practical and lawful difficulties. E-crime investigation plays a pivotal role in investigating IP infringements in cyberspace which arises through data breaches which jeopardizes further trademark infringement, trade secret exfiltration, patent infringement, and various other IP damages. The e-crime investigation procedure lays out a mechanism for reactively implementing detective control, corrective control, and proactively laying

out a mechanism for implementing deterrent controls, preventative controls, and other compensatory controls in e-commerce Social Engineering fraud IP infringements.

Keywords: Digital forensics, Social Engineering Fraud, Ecommerce, cyber-crime, Forensic investigation, Investigative Forensic Journalism

INTRODUCTION

Ecommerce is a combination of multiple integrated businesses such as manufacturing, logistics, supply chain management, and digital marketing, which includes all sorts of FinTech transactions with the assistance of the Internet[i] platform[ii]. Multiple sources of business assistance exist betwixt vendors, merchants, buyers and customers, sellers, and other third-party service partners, and multiple sources of technologies like cloud, mobile, IoT, artificial intelligence, etc. are also involved. Various processes, like operational, technical, technological, legal, and policy gaps, pave the way for bad actors to perform various sorts of crimes damaging IPR. Data is the primary source for committing a crime. Therefore, it has to be protected in this online business, which indirectly damages various sources of IP for an organization like trademarks, trade secrets, patents, etc. In many ways, this data exfiltration infringes on e-commerce IP like trademarks, patents, trade secrets, and data breaches due to a lack of control measures and cyber security policy lacunae. Threats to damage intellectual property through data leakage are possible internally within organizations through process non-compliance and theft. Internally, supply chain activities involve products of transshipments and trans-handoff between warehouses from vendors, merchants, sellers, delivery partners, and other third-party sources. Internally, under the roof process, noncompliance occurs by bad actors alongside data exfiltration and trade secret exfiltration. In a country like India, where cash plays a major role in business out on the road, scams happen by delivery agents and, in some cases, by abusive customers. The fraud motto of bad actors is not only for their financial benefit but also for damaging IP.

In many circumstances, bad actors are involved in espionage and sabotage, together with data exfiltration, trade secret exfiltration, impersonation, identity pilferage, and fraud and theft through many forms of cybercrime. These abusive activities will directly affect intellectual properties like trademarks, brand infringement, data leakage, and, in some cases, damaging copyrights, software patents, utility patents, process patents, product patents, etc. when it comes to public global forums. The cyberspace has no unique rules across the world, and this paves the way for social engineering fraud to damage IP across borders through data leakage. This article focuses on the protocols to be followed in a cybercrime investigation in the e-commerce industry. The investigation involves collecting the evidence in a forensically sound manner with the help of various tools and techniques, and a forensic report is drafted using the investigative forensic journalism method. These forensic reports go to legal, litigation, law enforcement agencies (LEA), and finally to court proceedings. All digital evidence in the form of technical logs and traces is to be converted into legal terms like facts of the case, men's rea, modus operandi, cause of action, parties to the case, findings, substantial evidence, prima facie in law enforcement, and court-understandable language connecting facts. Evidence with corrective Implementation of internal and external corrective controls and other controls like preventive controls, detective controls, and deterrent controls has to be carried out proactively.

PROBLEM AREA Lack of control measures, detective and corrective mechanisms for intellectual property damages caused by social engineering fraud (SEF) in the e-commerce industry.
PROPOSED SOLUTION cybercrime investigation framework as a control methodology to be included in the cyber security policies to safeguard intellectual property infringement in cyberspace.

RESEARCH QUESTION
a.   What laws and arrangements have been put in place in India to combat cybercrime in which there are intellectual property infringements, and how do web-based corporate enterprises handle these security issues?

b.   What are the prospective research directions and management consequences in the area of cybercrime and e-commerce intellectual property damages?

c.   How can a business prevent the most prevalent types of cybercrime, such as phishing emails, malware infections, phishing calls, and other potential e-commerce social engineering fraud that directly infringes on intellectual property?

d.   How could the challenges associated with identifying, prosecuting, and preventing cybercrime causing intellectual property damages be overcome?

RESEARCH OBJECTIVES

a.   To analyse the cyber security issues faced by e-commerce enterprises causing intellectual property infringement and the laws and policies implemented in India to regulate cybercrime.

b.   To evaluate the effects of cybercrime on managers and to determine the future paths for study in the area of cybercrime and intellectual property infringement in e-commerce.

c.   To research the difficulties in detecting, prosecuting, and preventing cybercrime causing intellectual property infringements and to provide ways to overcome them.

d.   To evaluate the legal measures taken against cybercriminals in India and the legislation implemented to control cybercrime in e-commerce and safeguard intellectual property infringements

CHALLENGES IN INTELLECTUAL PROPERTY INFRINGEMENT IN CYBERSPACE

Identify the person of interest, bad actor, or suspect. Tracing the geolocation, confirming the Act of Guilt (Mens Rea), and tracing the parties to the case are the primary challenges in a cybercrime that causes intellectual property infringements. Since all social engineering frauds are being operated remotely from cross-jurisdictions using VPN's advanced forensics tools and techniques, highly skilled forensics investigators are the need of the hour. Proving the potential impact, damage, or loss to law enforcement agencies, or in the court of law, reproducing the fact, damages, needs high-tech tools and skills. In today's era, proving the cybercrime infringement and recognizable offense/blue collar crime with Mens Rea and providing substantial evidence with Primafacie has become a tug of war.

SOURCES OF SOCIAL ENGINEERING FRAUD IN CYBERSPACE

In the cyber space, bad actors mostly attack through social media channels like Facebook, Twitter, Instagram, LinkedIn, YouTube, etc. by using multiple fake social media channels, social media pages, and social media groups. Bad actors rely on fake websites and fake domains for fintech transaction routing to a payment gateway in a hidden way. Messaging channel platforms like WhatsApp, Signals, Mobile Messages, and Telegram also act as the source of attack vectors. Bad actors do data exfiltration, trade secret exfiltration by espionage, sabotage, insider threats, and external bad actors do impersonation with identity theft through attack vectors in internet layers like the Surface Web, Deep Web, and Dark Web, which have multiple social media channels, messaging platforms, posts, blogs, forums, etc., which make it very difficult to track the person of interest or parties to the case involved in the act of guilt. Bad actors play the act of trade secret filtration, data filtration, reputation damage through data leakage by espionage, and sabotage, which causes data breaches, trade secret leakages, and impacts intellectual property like trade mark infringement, brand infringement, and data breaches through this social engineering fraud.

CASE STUDIES: PRESENTATION OF ECOMMERCE CYBER CRIME CASES

Here are some cybercrime case studies involving e-commerce that occurred between 2018 and 2023:

Fraud at the Pune Citibank MphasiS Call Center: In 2018, former employees of MPhasiS Ltd's Msourc E BPO cheated US Citibank customers out of 1.5 million dollars. The violation was committed via "unapproved access" to the clients' "Electronic Record Space." This situation raised questions about the competence of "information security" and fell under the category of "digital violations." In addition to Sections 43(a) and 66 of the Information Technology Act of 2000, the defendants were also charged with violating Sections 420, 467, 468, and 471 of the Indian Penal Code. The act entailed unlawful access to clients' electronic accounts, so the court determined that it constituted cybercrime and should be prosecuted under the IT Act. The accused, who were once employed at MphasiS BFL's Pune Call Centre, were given instructions to have cordial interactions with international Citibank callers who had inquiries

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regarding their credit cards and bank accounts. To prevent them from writing down duplicate account numbers, representatives entering and departing the call centre were inspected. The accused were implicated under sections 420, 467, 468, and 471 of the IPC,1860, as well as under sections 43(a) and 66 of the IT Act 2000.

THE CYBERFORENSICS AND E-DISCOVERY STRATEGIES USED IN THIS CASE ARE

a. The investigators captured the computer systems at the call centre using a write-blocker. This guaranteed the integrity of the original data.
b. Using a range of technologies, the detectives analysed the data from the call centre's information pricing systems. This includes tools for tracing data transfers, retrieving deleted files, and detecting viruses.
c. The experts compiled a summary of their findings. The prosecution used the report to convict the con artists.

MEESHO CASHBACK FRAUD: In 2021, there was a cybercrime called the Meesho Cashback Fraud. The main elements of the fraud were the bogus Meesho cashback websites that promised users money for Meesho purchases. However, when visitors submit their personal information on these websites, bad actors scam the customers. As a result of this extortion, the clients of Meesho lost around 100,000 INR (about $13,000).

DIGITAL FORENSICS AND E-DISCOVERY TECHNIQUES USED IN THIS CASE ARE

* The factfinders were able to recover an image of the Meesho servers by using a write blocker. This guaranteed the integrity of the original data.
* Using a variety of tools, the experts reviewed the data obtained from the Meesho servers. This includes tools for tracing data transfers, retrieving deleted files, and detecting viruses.
* The experts compiled a summary of their findings. The prosecution used the report to convict the con artists.

EBAY INVOICE FRAUD: In 2022, an eBay invoice fraud cybercrime occurred. Sending emails that seemed to be from eBay was part of the hoax. The emails contained links that, if activated, opened a fake eBay invoice. The bill would refer to the victim's debt to eBay. However, if the casualty paid the fee, the cybercriminals would take possession of the assets. As a result of this fraud, nearly 250,000 eBay consumers lost their money, of $32,500.

THE CYBERFORENSICS AND E-DISCOVERY STRATEGIES USED IN THIS CASE ARE

* The investigators employed a write-blocker to take a photo of the victims' PCs. The company guaranteed the integrity of the original data.
* The experts dissected the information taken from the subjects' PCs using a variety of tools. This includes tools for tracing data transfers, retrieving deleted files, and detecting viruses.
* The experts compiled a summary of their findings.The prosecution used the report to convict the con artists.

THE FOLLOWING LEGAL ACTIONS WERE TAKEN AGAINST THE ABOVE-STATED CASES

Two individuals involved in the Meesho cashback extortion and eBay invoice fraud were apprehended by the Delhi Police's cybercrime unit. Two people, Rahul Verma and Aman Kumar, are thought to be responsible for the crime. The perpetrators of the Meesho cashback fraud and the eBay invoice fraud were obligated to provide restitution to both the accused and the victims under Sections 66C, 66D, and 420 of the Indian Penal Code (IPC) and also under Section 66F of the IT Act of 2000. The court of law calculated compensation in accordance with the amount of money the victims lost.

The Information Technology (Amendment) Act of 2008 is the law governing this e-crime legislation. This legislation revised the IT Act of 2000, which included provisions associated with e-crime. Among the rule's major implementations are:

i.   Section 66C: This clause makes it illegal to cause the delivery of property by fraud. Under this clause, the perpetrators of the Meesho reimbursement fraud and the eBay invoice fraud were prosecuted.
ii. Section 66D: Fraud is now considered a crime under Section 66D. Additionally, this approach was utilized to convict the perpetrators of the Meesho payback scam and eBay invoice fraud.

iii.   Section 66F: This section outlaws cyberstalking. Even though Meesho payback scammers and eBay invoice fraud were not charged under this clause, they might have been if they had followed their victims around with private information.

LEGAL PROVISIONS FOR PROTECTING INTELLECTUAL PROPERTY INFRINGEMENTS IN CYBERSPACE

i.   Introduction of recent new amendments in the Indian Penal Code, 1860, which is renamed to Bharatiya Nyaya Sanhita 2023; the Criminal Procedure Code, 1973, renamed to Bharatiya Nagarik Suraksha Sanhita (BNSS) Bill, 2023; the Indian Evidence Act, 1872, renamed to the BharatiyaSakshya (BS) Bill; and the 2023 New Bill on Digital Personal Data Protection Act, 2023 brings many provisions to accept digital evidence and paves the way for considering digital evidence as primary evidence.

ii.   The admissibility of electronic records as per Section 65B (4) of the Indian Evidence Act, 1872, are Section 65A and Section 65B, namely subsections 65B (2), 65B (3), and 65B (4), and also Section 14 of the Information Technology Act of 2000 for securing electronic evidence.

iii.   Section 499, 500 of the Indian Penal Code for Defamation, Section 416 of the IPC for Impersonation, Section 40 of the IPC for Offense, and its damages

iv.   Section 28(1), Section 27(2), and Section 134(c) of the Trademark Act, 1999, provide a right to get relief against the infringement of trademarks in accordance with the provisions of the Act. The acts of trademark infringement under Section 29 and passing off under Section 27 can raise a legal cause of action, which may be pursued by filing a lawsuit under Section 134. In light of the facts gathered, we need to establish the presence of several factors, such as loss of reputation, possibility of confusion or deception, misleading designation of origin or association, fraudulent advertising, and others, in order to substantiate our claims. The Trademarks Act of 1999 has two key provisions, namely Section 27, which addresses the concept of passing off, and Section 29, which deals with infringement.

v.   Section 66D for impersonation and Section 66C for identity theft of the Information Technology Act of 2000.

PROCEDURAL STEPS IN CYBER CRIME INVESTIGATION AND LAW ENFORCEMENT ACTION

i.   As a first step, a cybercrime investigation starts with reactive measures, implementing detective control, investigating an intellectual property infringement by performing cybercrime intelligence, building a profile as a forensics investigation report, and collecting all sources of evidence.

ii.   Secondly, based on the use case, modus operandi key words, and watch words through cybercrime research, we need to set up a mechanism for manual analysis, human intelligence, and open source intelligence using freeware tools and techniques. Once we find a mechanism to investigate reactively, this has to be built as proactive preventive control, deterrent control, converting the investigation methodology embedding into an AI/ML expert system, and developing an algorithm during the cybercrime research to hunt all ongoing true positive cyber threats.

iii.   Thirdly, this proactive measure of preventive control and deterrent control by detecting ongoing cybercrimes that may potentially impact has to be identified proactively and necessary corrective controls taken through AI/ML model expert systems developed and configured as a software-as-a-service (SaaS)-based platform.

iv.   In cybercrime investigation during intelligence, research, and hunting, various forms of evidence like direct evidence, documentary evidence, material evidence, and circumstantial evidence are collected using the following 5 approaches:

a. A systematic approach to the collection of evidence is the process of conducting an interview, like the PEACE, REID technique, or Wicklander-Zuwalski (WZ) method of interview, which involves gathering comprehensive information by addressing the fundamental synergy of questions of how, when, where, who, why, and what (often known as the 5W+H) with the geographical location, date, and timestamp of the incident. Additionally, it entails thoroughly reviewing all audit reports and prevailing industrial legislation pertaining to governance, risk, and compliance. This helps to understand the facts of the case.

b. The analytical approach employed in this study involves an analysis of the use case and modus operandi through the utilization of business analytics, data analytics, and data science techniques, with a focus on identifying data

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trends and patterns of a crime's past, current, and future projections relating to the use case and confirming the modus operandi.

c. Audit evidence helps to understand the gap and cause of action by performing a risk management framework and various integrated forensic audits like process, operational, functional, and technical audits to identify gaps and find the cause of action. The Risk Management Framework and the execution of an integrated information systems audit are employed to ascertain the MensRea, potential impact, damage, loss, financial theft, loss, issue, problem, root cause of the issue, and solution in relation to governance, risk, and compliance (GRC). The Risk Management Framework application includes the utilization of a risk register, which comprises many key stages: risk identification, risk analysis, risk evaluation, risk treatment, and risk monitoring. This will aid in the compilation of audit evidence and the identification of any deficiencies or gaps both internally within the organization and externally in the cyber space.

d. Performing a data protection impact assessment to find the data security lacuna and develop a data protection policy. The purpose of conducting a Data Protection Impact Assessment (DPIA) is to identify any deficiencies in data control, establish appropriate security measures, and determine the necessary controls to be implemented at the data level.

e. Finally, collect all historical evidence, like computer forensics, mobile forensics, IoT forensics, semiconductor chip-off forensics, open source intelligence, social media forensics, email forensics, network forensics, database forensics, multimedia forensics, and biometrics forensics, and collect various forms of evidence that are left as traces.The historical approach employed in this investigation involves the utilization of vendor AI-driven tools, open source tools, manual analysis, and human intelligence. These methods are employed with cross-examination to confirm the presence of true positive artifacts in the evidence and to determine the parties involved in this case, the cause of action, the person of interest, the victim, substantial evidence, and the prima facie elements of the case.

MECHANISM OF EVIDENCE COLLECTION IN IP INFRINGEMENT CYBER CRIME

The mechanisms of evidence collection include direct evidence, document evidence, material evidence, and circumstantial evidence of the facts of the case.

a. All the evidence collected is to be substantiated by verifying that the evidence collected is only true positive evidence by performing cross-examination in the cybercrime investigation lab through manual analysis examination, open-source tool and technique examination, and AI/ML-based tool and technique examination to prove the prima facie.

b. Building the facts of the case has three steps: collection of evidence, recording psychological factors of the crime scene, and recording panchanama, which is the post-crime effect of the crime scene, alongside the chain of custody (condition of evidence, who collected it with a date and timestamp, and who is currently holding it), and the chain of evidence (order and manner of evidence handled) for law enforcement actions.

c. Law Enforcement Referral Action Protocols like filing a Community Service Report (CSR), a police complaint, a First Information Report (FIR), and a Charge Sheet are to be given with an investigation report and further moved into court for prosecution and conviction.

d. The zero FIR process for cross-jurisdiction FIR filing, along with raising an online police complaint to the Indian Cyber Crime Coordination Center of the Ministry of Human Affairs Cyber Crime, expedited the process of law enforcement actions.

e. A corrective control mechanism to be implemented within the organization, both internally and externally, in the government, public sector, and private sector, like TRAI, IANA, ISP, cloud service provider, and NPCI, controls

f. Evaluate the corrective controls statistically, studying through data analytics andforecasting through data science, and evaluating key risk indicators vs. key performance indicators on reactive measures vs. proactive measures as continuous monitoring.

g. Implementing defense-in-depth controls to protect intellectual property in the Internet and cyberspace, like preventive controls, deterrent controls, detective controls, and corrective controls, by continuously monitoring all social engineering frauds in cyberspace to protect intellectual property damages and all FinTech crimes

h.　This diligent cybercrime investigation will help the Law Enforcement Agency (LEA) conduct easier interrogation and enable the preparation of a comprehensive cybercrime investigation report to prove the prima facie.

i.　All evidence should be generated with a master copy and a working copy, employing authorized tools and processes alongside the forensics investigation report, annexing the chain of custody report, and the chain of evidence report.

j.　The Cyber Crime Investigations report should be written in an active voice and narrative in a sequential presentation that is to be conclusive and supported by augmented data. It should address internal investigations within business and propose internal corrective controls, as well as external investigations in the cyber space and recommend external corrective controls through collaboration with law enforcement agencies and courts. The Cyber Crime Investigation report should have Fact of the Case, Modus Operandi, Mens Rea, Parties to the Case, Cause of Action, Findings, Substantial Evidence, Primafacie, and conclude with recommendations, suggestions, and a prayer from technical logs to be converted in a legal language with forensically sound evidence.

CORRECTIVE REGULATORY MEASURES

Corrective regulatory protection from intellectual property Infringement on the internet can be classified into two categories: internal corrective control and external corrective control.

INTERNAL CORRECTIVE CONTROL WITHIN THE ORGANIZATION

i.　**ADMINISTRATIVE CORRECTIVE CONTROL**: Internal managerial corrective control refers to the implementation of organizational policies that are not adequately monitored. These procedures encompass the evaluation of governance, risks, compliance, and the regular conduct of forensic auditing. Additionally, the practice of assessing governance, risk, and compliance (GRC) is done promptly and without delay.

ii.　**Technical Corrective Control**: Internal technical corrective controls include various measures such as threat hunting, threat intelligence, threat research, vulnerability assessment, penetration testing, and addressing other technical vulnerabilities in infrastructure, coding, and cyber security to enhance security.

iii.　**Remedial Corrective Control**: Internal Remedial has two parts: Relief Corrective regulation refers to the steps taken within the firm to address and rectify any losses incurred. These steps may include conducting interviews and interrogations, recovering losses as clawbacks, and punishment like separating employees involved in malpractice and closing accounts of abusive customers, as well as seller accounts and other corrective actions.

EXTERNAL CORRECTIVE CONTROL IN THE CYBERSPACE

I. ADMINISTRATIVE CORRECTIVE CONTROL: One potential approach to resolving the matter of IP damages caused by data exfiltration on the internet is the implementation of external managerial corrective measures. These measures involve the identification of individuals engaging in malicious activities, supported by solid evidence and monitoring their online activities. By doing so, it becomes possible to refine existing policies, rules, regulations and laws governing the internet. This approach aims to mitigate the risks associated with the exfiltration of data and safeguard IP. Public sectors and government organizations, such as the Indian e-Crime Coordination Centre (IeCC), the National Payments Corporation of India (NPCI), the Reserve Bank of India (RBI), the Telecom Regulatory Authority of India (TRAI), the Internet Assigned Numbers Authority (IANA), the National Cyber Crime Cell, Interpol, the legislature, and the judiciary, should possess knowledge of prevailing trends and patterns of Modus Operandi. This awareness guides the implementation of managerial corrective steps in strategies, rules, regulations and laws.

II.TECHNICAL CORRECTIVE CONTROL: Managerial measures such as the takedown of impersonating entities, brand violations, trademark violations, fake URLs, fake websites, fake social media pages, bad actor cell phone numbers, bank accounts, and email addresses should be executed. Additionally, robust internet security controls and exfiltration of data checks should be put in place to protect against potential threats on the internet. Furthermore, it is crucial to incorporate effective awareness into training, awareness, and education programs to mitigate the impact on vulnerable individuals.

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III.REMEDIAL CORRECTIVE CONTROL: It involves the creation of a digital forensics investigation report that includes factual information about a case involving a blue-collar crime and the mental state of the perpetrator, known as Mensrea. This report provides evidence supporting the occurrence of various IP damages, such as brand infringement, trademark infringement, impersonation, identity theft, defamation, social engineering fraud, and financial loss. Create a comprehensive profile and submit the investigation report to law enforcement agencies for the purpose of implementing remedial measures like punishment and relief measures through court trial, prosecution, and conviction. These measures aim to establish deterrent controls, provide continuous observation, and execute checks and balances, to address all cybercrimes related to data exfiltration and IP damages in electronically connected environments. The e-Crime Investigation Report should encompass all instances of cybercrime, ensuring that it adheres to the principles of secrecy, uprightness, and availability (SUA), and there should not be any tampering with evidence like disclosure, alteration, and destruction (DAD). This report should be comprehensible and acceptable to Law Enforcement Agencies (LEA) and courts, enabling the filing of a Community Service Register (CSR), a police complaint, and subsequently converting it into a First Information Report (FIR). The report should also facilitate the creation of a charge sheet, which can be utilized in the prosecution and conviction of the perpetrator during the trial. This comprehensive approach aims to protect IP assets, facilitate the remediation and recovery of damages, and impose appropriate penalties and punishments. This encompasses several forms of control, including preventive control, deterrent control, investigative control, remedial measures, and compensatory measures that are compensatory in nature and work in conjunction with each other to protect intellectual property infringements on the internet.

INFERENCE FROM THE ABOVE CASE STUDIES

i. The modules of advanced legal sciences encompass several components, such as the identification, collection, preservation, safeguarding, investigation, documentation and presentation of evidence. The acquisition and evaluation of digital evidence at every level are crucial in cases of cybercrime pertaining to e-commerce.

ii. Standard forensic science procedures, such as fingerprint analysis, hand geometry analysis and other biometric forensic and cognitive analyses, have the potential to augment digital evidence. The aforementioned statement underscores the need to employ recognized procedures from the field of legal science in the context of complex criminological investigations.

iii. Case studies investigating instances of cybercrime in the realm of e-commerce provide valuable insights into the diverse manifestations of cybercriminal activities and their impact on individuals and enterprises. The need to employ advanced criminology and e-discovery methods to collect and assess digital evidence in such scenarios is further elucidated by these contextual studies.

iv. The contextual studies offer an illumination of the process involved in acquiring and evaluating intricate evidence in such instances through the use of computerized criminology and e-disclosure methodologies. The potential solutions put forth to address these concerns may potentially give rise to further challenges pertaining to the preservation of the rule of law and the protection of fundamental rights.

v. Hence, it is necessary to adhere to a specified cybercrime investigation procedure in investigating intellectual property infringements resulting from a data breach through social engineering fraud in the e-commerce business.

IMPLICATION

The phases of the digital forensic framework include identification, collection, acquisition, preservation, analysis, documentation and presentation. Computerized evidence can be supported by standard, measurable scientific methodologies and sophisticated exams can benefit from the use of criminological science techniques. It is significant to apply well-established legal science methodologies to sophisticated criminology investigations. A significant barrier to the collection of digital evidence in cases of online commercial cybercrime is the global nature of cybercrime. It is crucial to address these issues and challenges in e-commerce cybercrime investigations to gather and examine digital evidence efficiently. Digital evidence is crucial to criminal investigations and prosecutions for intellectual property infringements in cyberspace, but it is laden with challenges, such as the admissibility of digital evidence, the integrity of digital evidence, the rapid evolution of technology, practical and legal challenges. The use of digital evidence in criminal investigations is rising across the board, not just for e-crimes. Investigate the

application of new technical developments and how they affect the reduction of cybercrime and enhance police effectiveness in governing. Intellectual property infringements in cyberspace

CONCLUSION

The cybercrime investigation procedure is crucial for gathering and evaluating digital evidence in e-commerce intellectual property infringement cybercrime cases, which are caused through data filtration and constitute a serious threat to intellectual property rights. This article helps to review the current security policy, procedures and technical weaknesses to take remedies like relief and punishment theory to balance various controls as intellectual property protection measures. Advanced legal sciences include identifiable evidence, assortment, securing, protection, examination, documenting and presentation in their modules. Science-based methods can be used to enhance advanced investigations and computerized proof can be supported by quantifiable science techniques. Case studies of e-commerce cybercrime shed light on the many forms of cybercrime and their possible consequences for both individuals and businesses. For obtaining and analysing digital evidence in situations involving e-commerce cybercrime, digital forensics and e-discovery techniques are crucial. The computerized legal sciences approach is used in a few steps, including identification, collection, procurement, security, safeguarding, investigation, documentation and presentation, to be followed in e-commerce social engineering fraud and intellectual property damages. Digital evidence can be subjected to forensic science procedures and forensic science methods can enhance digital investigations and thereby protect intellectual property rights in cyberspace.

Suggestion

Future cybercrime investigation procedure studies should integrate digital forensics practices into online governance frameworks for data protection regulations and establish effective cyber security policies that protect intellectual property assets like copyrights, trademarks, patents, trade secrets, semiconductor chips, industrial layout designs, geographical indications, and other intellectual property rights. Ecommerce involves FinTech transactions between vendors, merchants, buyers, sellers, and other third parties. This complicated network of interactions allows cybercrimes in organizations online to impact intellectual property damages. These cybercrimes can cause trademark infringement, brand infringement, reputational damage through impersonation, identity theft, and data breaches via social media channels, messaging channel platforms, blogs, forums, fake websites, and fake social media pages through social engineering fraud on the surface web, deep web, and dark web. These damages usually result from unauthorized data harvesting and breaches. Copyright, patents, trademarks, trade secrets, industrial and layout designs, geographical indications, and other intellectual property rights should be authorized and governed by cyber security policies to keep them aligned with enterprise policy along with national and international laws.

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REVIEW ARTICLE

Development of Various Visual Aids for Polycystic Ovarian Syndrome (PCOS)

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ABSTRACT

PCOS affects millions of women without their knowledge. In fact, PCOS is considered to be the most common cause of infertility in women today (Diamanti- Kandarakiset al., 1998).**Aim**: To develop various visual aids for PCOS. To generated various visual aids for PCOS aimed to impart nutrition education for emerging adult women 'at risk' of PCOS. It's a Prospective study done in 2016. Nutrition education materials including Pamphlets, Charts, Model and PowerPoint presentation was created for emerging adult women 'at risk' of PCOS. An instructional pamphlet was prepared for the participants of the study which mainly highlighted the importance of good nutrition during PCOS condition. A chart with the details of characteristics, signs, symptoms and diet for PCOS was prepared. The Food Guide Pyramid helps to promote the THREE basic rules for a healthy diet: Variety, Balance and Moderation. Overview of PCOS and its management were included in slides. Education has helped to change the attitude of the individual thus making effecting changes in the dietary pattern and lifestyle. Developed power point presentation gave an over view of the importance of nutrition for PCOS, whereas, chart and pamphlet are a comprehensive resource of characteristics, signs, symptoms associated with PCOS. The models help in good food selection for emerging adult women 'at risk' of PCOS.

Keywords: PCOS, Visual aids, Nutrition education, Pamphlets, emerging adult women.

INTRODUCTION

PCOS affects millions of women without their knowledge. A PCOS woman experiences many symptoms that can have a significant and long-term impact on their self-esteem and body image and they are at a higher risk for developing an eating disorder **(1).** Estimates range anywhere from 6 to 20 % of the female reproductive population, and the number may be even higher among younger women, since infertility is the primary clue that leads to most diagnoses. In fact, PCOS is considered to be the most common cause of infertility in women today **(2).**Diet and exercise are important parts of managing PCOS. This is because young women with PCOS often have higher levels of insulin in their blood, and many have trouble maintaining a healthy weight. Knowing the right foods to eat as well as the kinds of food to limit can improve the health status and also help to lose weight. Eating well, staying active, and maintaining a healthy weight or losing even a small amount of weight in overweight condition can improve PCOS symptoms **(3).**Community trails suggests that nutrition education is an accessible effective tool in health promotion programs with a focus on the development of healthy eating practices(4).

METHODOLOGY
Aim
To develop various visual education aids for PCOS subjects.
Objective
To generated various visual aids for PCOS aimed to impart nutrition education for emerging adult women 'at risk' of PCOS.
Research Design
It's a Prospective study, performed in the year 2016.Nutrition education materials including Pamphlets, Charts, Models and Power point presentation was created for emerging adult women 'at risk' of PCOS.
NUTRITION EDUCATION MODULES

RESULTS AND DISCUSSION
Effective Nutrition education sessions can be provided for emerging adult women 'at risk' of PCOS, with the help of pamphlets, charts, models and power point presentation. Created visual aid semphasized the importance of nutrition in PCOS condition. The prepared pamphlets can be distributed as educational aids to understand the concept of PCOS nutrition.
Pamphlets
 A pamphlet is a folded paper that has information about the particular subjects. The definition given is that a pamphlet is an unbound booklet. It may consist of a single sheet of paper that is printed on both sides folded in half, in thirds or in fourths to make a simple book **(5).**An instructional pamphlet was prepared for the participants of the study which mainly highlighted the importance of good nutrition during PCOS condition and which also has the pictorial representations of the major sources of each nutrient beneficial for PCOS[Plate 1 (a,b)]. A colorful, informative, attractive and easy to carry pamphlet was prepared focusing on the following:
1.　What is PCOS?
2.　Common symptoms
3.　Health risks
4.　Management of PCOS
5.　Dietary and Lifestyle Guidelines for PCOS
6.　Exercise

The pamphlets provided easy to follow food and nutrition tips in a convenient format for emerging adults.

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Charts

A chart was prepared with the details of characteristics, signs, symptoms of PCOS and that can be explained to the respondents gathered at different venues. The created chart is shown in Plate 2.

Models

The Food Guide Pyramid [Plate 3]helps to promote the THREE basic rules for a healthy diet: Variety, Balance and Moderation. **Variety** means many different foods from each level of the Food Pyramid because no single food can supply all the nutrients. **Balance** means, eating right amounts of foods from all levels of the Food Pyramid to meet the calories and other nutrients required for proper growth and development. **Moderation** means that one is careful not to eat too much of any one type of food. Each day, the right amounts of servings from each of the food groups depend on the age, sex, and activity level. were used to serving size demonstration can be done with the help of measuring cups and spoons [Plate 3 (a,b)].

Power Point Presentations

A power point is a complete presentation graphics package. It is a slide-based presentation program which offers enormous customized scope for word processing, graphics and animations. It is a powerful visual aid that helps to reach out to the masses [Plate 4 (a,b)]. Informatory power point was prepared with 20 slides containing the following

1. PCOS – An overview
2. What Causes PCOS? Diagnostic criteria for PCOS
3. Clinical presentation of women with PCOS
4. PCOS: Signs and symptoms
5. Consequences of PCOS
6. Treatment
7. Nutrition therapy for PCOS
8. Exercise

CONCLUSION

Nutrition education for women 'at risk' of PCOS is mandatory and the facts can reach effectively among the target population when it has been conducted with appropriate education material. In that aspect, the power point presentation prepared for an over view of the importance of nutrition for PCOS with relevant pictures and animations, reinforced with vivid explanation. The chart and pamphlet are a comprehensive resource of characteristics, signs, symptoms and role of nutrition in PCOS. The food pyramid helps the selected emerging adult women 'at risk' to choose foods based on the nutrient content. Finally, the models can teach them the THREE basic rules for a healthy diet: variety, balance and moderation.

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Fig 1: a) & b)PAMPHLETS

Fig 2:CHARTS
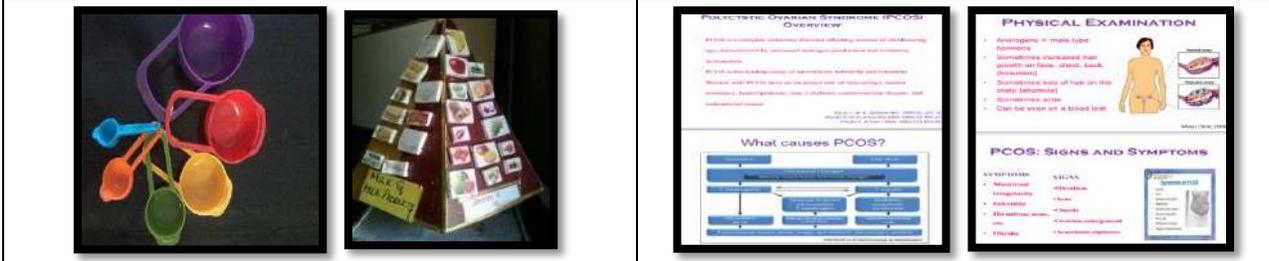
Fig 3:a) & b)MODELS

Fig 4:a) & b) POWER POINT PRESENTATIONS

RESEARCH ARTICLE

In vitro Evaluation of Anti-Ulcer Activity of Karanthai Legium

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ABSTRACT

In this modern era, Ulcer is the most common gastro intestinal disorder which seen among many people. It is basically due to inflamed break of skin or mucous layer. It occurs due to regular usage of drugs, stress, spicy or junk food and irregular food intake. In Siddha literature, Ulcer (Gunmam) is a clinical entity which depresses both body and mind. There are many herbs in the management of ulcer. In Siddha medicine contain 64 therapies were divided into 32 internal and 32 external therapies. Among them Legium is one of the internal medicine which is sweet and palpatable by the patient. Karanthai legium(KL) is one of the herbo mineral drug for kunmam,soolai, yoniputru. In this study, we assessed for anti-ulcer activity by invitro method of acid neutralizing capacity(ANC) and H^+/K^+-ATPase inhibition activity. In ANC, the extract of KL significantly reduced ANC to 14 at a concentration of 1000mg as compared to 15.7 with standard Aluminium hydroxide + Magnesium hydroxide (500mg). While in H^+/K^+ - ATPase inhibition activity, the extract showed maximum percentage inhibition of 67.86% at the concentration 500µg as compared to 70.2% with standard Ome prazole.

Keywords: Anti- ulcer, Gunmam, Siddha medicine, Karanthai Legium, Peptic ulcer

INTRODUCTION

Peptic ulcer (PU) is a common, chronic and occasionally life- threatening disease of poorly defined pathogenesis among human population [1, 2]. The prevalence of Peptic ulcers is now a day increasing among the population due to the unhealthy food habits of the people. It is a break in the lining of the stomach, the first part of the small intestine, or occasionally the lower esophagus due to contact with the chloride peptic secretions [3]. PU manifest as a non-fatal disease, majorly represented by periodic symptoms of epi gastric pain, which are often relieved by food or alkali, besides to trigger much discomfort to patients, disrupting their daily routines and also causing mental agony [4]. All ulcers of the upper gastrointestinal tract were originally thought to be caused by the aggressive action of pepsin and gastric acid on mucosa. Increase in gastric acid and pepsin secretion, decrease in gastric blood flow, suppression of endogenous generation of prostaglandins, inhibition of mucosal growth and cell proliferation, and alteration of gastric motility have been implicated in the pathogenesis of gastric ulcer [5]. However, the denomination "peptic ulcer" has lately pointed to Helicobacter pylori infection, where the chronic use of non-steroidal anti-inflammatory drugs (NSAIDs) and acetylsalicylic acid (ASA) are some of the disease-causing factors [6].Due to the occurrence of many side effects by use of synthetic drugs for many diseases. The herbal medications are considered as the main source of drugs for ulcer, as they have less or no side effects. In Siddha literature, Ulcer (Gunmam) is defined as a clinical entity which depresses both body and mind. Karanthai legium (KL) is one of the herb mineral preparation mentioned in bogar aruliya vaithiya saram 700,indicated for 8 types of Gunmam(ulcer), kiranthi, karappan, soolai(Pain), kanna putru,linga putru,yoni putru, pilavai putru(cancer). Legium which is sweet and palpatable by the patient. Hence this study, to validate the anti-ulcer activity of Karanthai legium by in-vitro method of acid neutralizing capacity(ANC) and H^+/K^+-ATPase inhibition activity.

MATERIAL AND METHODS

The raw drug was purchased in Ramasamy Chettiyar, Paris, Chennai and autheniticated by botanist and from Department of Gunapadam ,National Institute of Siddha ,Chennai. The root of karanthai was collected from thiruvanmalai district.

INGREDIENTS

Thirikadugu (*Zingiber officinalis*,*Piper nigrum*,*Piper longum*),*Kadukkai*(*Terminalia chebula*),*Thandrikai*(*Terminalia bellirica*),*Vasambu* (*Acorus calamus*),*Indhuppu* (Rock salt),*Valuluvai* (*Celastrus paniculatum*),*Kostam*(*Saussurea lappa*),*Karunjeeragam*(*Nigella sativa*),*Omam* (*Trachyspermum ammi*),*Arasu*(*Ficus religiosa*),*Elam*(*Elettaria cardamom*),*Manjal*(*Curcuma longa*),*Karboga arisi* (*Psoralea corylifolia*),*Seviyam*(*Piper nigrum* – black peper root), *Vaividangam* (*Embelia ribes*),*Anai thipilli*(*Scindapsus officinalis*),*Jathikai* (*Myristica fragrans*),*Shenbaga poo*(*Michelia champaca*),

PROCEDURE

All above raw drugs expect karanthai were purified, grind and made into a fine powder. Root of Karanthai was cleaned, dried and made into a powder. To the net weight of above raw drug powder, add equal quantity of karanthai root powder and mixed well. Ghee was melted and add these powders gently and mixed well. Finally add honey and stirred it completely [7].

IN-VITRO EVALUATION OF ANTIULCER ACTIVITY
Acid Neutralizing Capacity

The aqueous extract of acid-neutralizing capacity value is 100mg, 500mg, 1000mg . The aluminium hydroxide and magnesium hydroxide (500mg) have compared for the standard. The total volume was 70ml with the addition of 5ml of a quantity of the mixture and remaining with water to make up the total volume; mix this for one minute. To the standard and test preparation, the 30ml of 1.0 N HCl was added and stirred for 15 minutes after that phenolphthalein was added and mixed. With 0.5N Sodium hydroxide, the excess HCl was immediately titrated until the pink colour is attained 15[8]. The moles of acid neutralized is calculated by, Moles of acid neutralized = (vol. of HCl × Normality of HCl) - (vol. Of NaOH × Normality of NaOH) Acid neutralizing capacity (ANC) per gram of antacid = moles of HCl neutralized divided by Grams of Antacid/Extract.

H+/K+ - ATPase Inhibition Activity
Preparation of H+/K+ - ATPase Enzyme

To prepare H+/K+ - ATPase enzyme sample the fresh goat stomach has purchased from the local slaughterhouse, the gastric mucosa of the fundus was cut-off and opened, the inner layer of the stomach has scrapped out for the parietal cell. The parietal cell obtained from the stomach has homogenized in 16mM Tris buffer with PH of 7.4, which has 10% Triton X-100 and centrifuged at 6000 rpm for 10mins after centrifuged the supernatant solution has used for the H+/K+- ATPase inhibition Protein content are used to find out according to Bradford's method were BSA are used for standard.

Assessment of H+/K+ ATPase inhibition

Per-incubated for 60 min at 37 °C for the reaction mixture of the sample containing 0.1ml of enzyme extract (300µg) and plant extract with different concentration (20µg, 40µg, 60µg, 80µg, 100µg). The reaction was initiated by adding substrate 2 mM ATP (200µL), in addition to this 2mM MgCl2 (200µL) and 10mM KCl (200µL) has added. After 30 min of incubation at 37 °C the reaction was stopped by 4.5% ammonium molybdate, and 60% perchloric acid was added and centrifuged at 2000rpm for 10 min, and in spectro photo metrically inorganic phosphate was released and measured at 660nm by following the Fiske-Subbarow method. Briefly, at 10 min at room temperature, 1ml of supernatant 4ml of Millipore water, 1ml of 2.5% of ammonium molybdate, 0.4ml of ANSA was added. At 660nm inorganic phosphate, absorbance has been measured at various doses of the extract; the enzyme activity has been calculated as micromoles of Pi released per hour [9].Results were compared with the known anti-ulcer PPA inhibitor Omeprazole and expressed as Mean ± SEM 16 % enzyme inhibition has calculated using the formula:
Percentage of inhibition = [Activity (control) - Activity (test)/Activity (control)] × 100

RESULTS

Acid Neutralizing Capacity

The neutralizing effect of KL was studied for concentration (100mg,500mg,1000mg) and standard Aluminium Hydroxide + Magnesium Hydroxide [Al(OH)3+Mg(OH)2](500mg). The results obtained envisage that the extract VOK at concentration100mg, 500mg,1000mg showed a significant reduction in acid neutralizing capacity (ANC), i.e.,119,14,10.5 respectively, as compared to standard Al(OH)3+Mg(OH)2 (500 mg) which is 15. The extract of VOK at a concentration of 500 mg has been found to neutralize acid more significantly as compared to standard. The results have shown in Table 1 & Fig 1

H+/K+ - ATPase Inhibition Activity

The H+/ K+ - ATPase inhibition activity of aqueous extract at a various concentration (100μg, 200μg, 300μg, 400μg, and 500μg) has compared with Omeprazole as standard. The extract significantly showed activity in a dose dependent manner. Maximum percentage inhibition of has been observed for extract KL 67.86% at a concentration of 500μg is and standard Omeprazole showed 71.43 %. The results have been tabulated in Table 2 &Fig 2.

DISCUSSION

The causes of peptic ulcer is unclear in most of the patients it may results of imbalance between aggressive factors and the maintenance of mucosal integrity through the endogenous protection system [10]. Peptic ulcer disease (PUD) has various causes includes Helicobacter pylori-associated PUD and NSAID-associated PUD account for the majority of the disease etiology [11]. Eating spicy food substances increases the symptoms of ulcers; the other symptoms are nausea, vomiting, and weight loss. Although patients with gastric ulcers have normal or diminished acid production, yet ulcers may occur even in the complete absence of acid [12].Acidity is a common gastrointestinal problem due to excessive secretion of gastric acid or stomach acid inflames the stomach lining mucosa and produces ulceration [13]. Antacids act by neutralizing gastric acid and thereby reduce the gastric pH [14]. The acid neutralizing capacity of an antacid is the amount of per gm of acid that it can neutralize [15]. In Siddha medicine, Karanthai legium is one of the herbomineral medication inclicated for 8 types of gunmam(ulcer). The entire drugs in Karanthai legium have individual anti-ulcer activity mentioned in previous studies. The phytochemical analysis of the Spaeranthus amaranthoides revealed the presence of saponins and flavonoids, substances known to affect the integrity of mucous membranes. Flavonoids have also been reported to offer some protection in ulcer development by increasing capillary resistance and improving microcirculation [16]. From this study, In Acid neutralizing capacity (ANC), the extract at 500mg concentration showed a significant reduction in ANC of 14. H^+ -K^+ ATPase is a key enzyme in inducing acidity; in this study, the ability of Karanthai legium (KL) to inhibit H^+ -K^+ ATPase in vitro isolated from goat stomach was studied. Enzyme H^+ -K^+ ATPase is an important enzyme system located on apical secretory membrane of partial cell [17]. In this study, dose-dependent inhibition of enzyme by omeprazole and extract KL was observed, suggesting that the Karanthai legium (KL) was significantly able to inhibit enzyme H^+ -K^+ ATPase, responsible for the secretion of acid and effect was comparable to omeprazole.

CONCLUSION

The results of our study prove that the Karanthai legium possess antiulcer activity by Acid neutralizing capacity and H+/K+ - ATPase inhibition activity Hence, it can be suggested that the antiulcer activity of the karanthai legium , as a natural herbal remedy in the treatment and management of ulcer. This is a premilinary study and to validate the siddha literatue and clinical trials to be conduct in future.

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Table 1: Effect of Karanthai Legium (KL) of on Acid Neutralizing Capacity

Concentration (mg)	Volume of NaOH consumed (ml)	mEq of Acid Consumed	ANC per gram of Antacid
100mg KL	36.2	11.9	119
500 mg KL	46	23	14
1000 mg KL	39	10.5	10.5
500 mg [Al(OH)3+Mg(OH)2]	45	7.5	15

Table 2: Effect of Karanthai Legium (KL) on H+/K+ - ATPase Inhibition Activity

S.NO	Concentration ((µg)	Standard Ompeprazole	Sample KL
1	control	0.00	0.00
2	100	25.00	10.71
3	200	35.71	14.29
4	300	42.86	53.57
5	400	57.14	57.14
6	500	71.43	67.86

Figure 1: Effect of *Karanthai Legium* (KL) on Acid Neutralizing Capacity

Figure 2: Effect of Aqueous Extract of KL of on H+/K+ - ATPase Inhibition Activity

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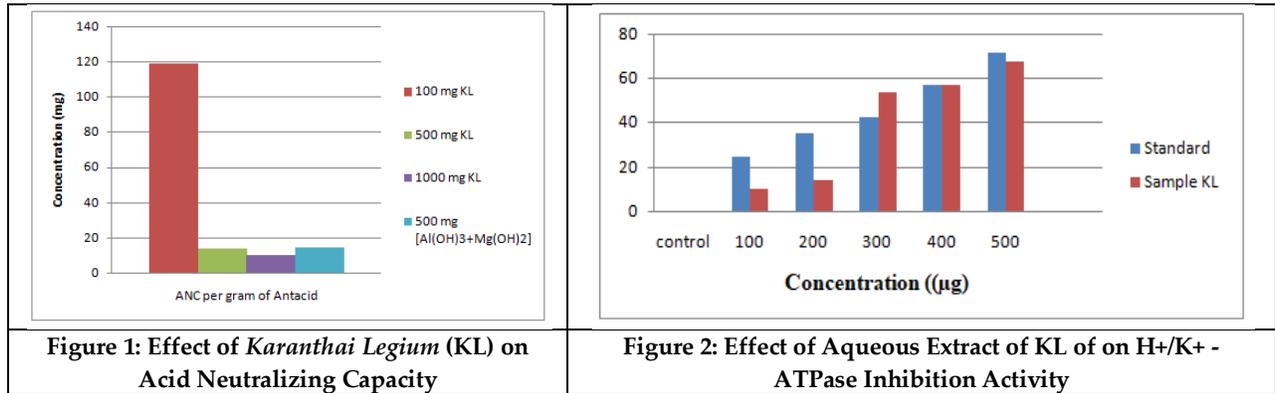
Devotional Music, Stimulation for Mung Bean Seed Germination

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ABSTRACT

Science reveals that Vibration is an elemental property, all matters exist in a state of vibration, and sound is a phenomenon associated with vibration. Indian Vedic spiritual scriptures ascribe that sound is the foremost qualitative phenomenon that appears in the very process of creation of this universe. Sound is a natural factor like light, water, air, nutrients, etc and with the development in acoustic science, its role in plant growth and development is gaining a gradual impetus. Studies available so far indicate that sound too play an important role in growth, development, and plant communication like other natural factors; and rhythmic sound or music has a better prospect for its application. Experimental research on the stimulation of Mung bean (*Vigna radiata*) seed germination with devotional music to this prospective revealed that devotional music had a positive effect on Mung bean seed germination in terms of germination percentage and germination index when administered in an optimum dose. An exposure of Mung bean seeds to devotional music with a sound pressure level of 90-100dB for 2hours per day resulted in significant improvement in radicle development and overall seed vigour index in comparison to the control group not exposed to devotional music. Radicle development and seed vigour index of Mung bean seeds exposed to devotional music increased by 101.1% and 110.48% respectively.

Keywords: mung bean, seed germination, seed vigour index, devotional music

INTRODUCTION

Vibration and sound are integral parts of the environment. It is present, in the form of vibration as a state of matter (Biard, 2014; Shabda Brahman - Wikipedia, n.d.), as natural forces acting on matter, present in the life-building processes from the cellular action (Jaross, 2016) to thoughtful activities of higher living beings. Sound is happening naturally in this creation; sound is also happening in the developmental activities of human beings (Goswami and Swain, 2017). Therefore, all organisms, plants and animals are existing and thriving somewhat in a direct and continuous interaction with the sound phenomena. Then, what role does this sound play in the life and development of a living beings become a matter of very genuine query and has great potential (Gagliano, 2013a). While interaction of plants with the natural factors like Light, Temperature, Air, Water, Nutritional Elements etc, has received much attention in the science and scientific communities, the study of Sound as naturally occurring stimuli remains undervalued (Mishra et al., 2016). However, with the developments in acoustic science, it is evident that studies of the acoustic impact on plants have gained rapid attention from plant and behavioural scientists in last few decades (Gagliano, 2013b). Studies in the past have given a definite direction to the fact that sound as stimulation to plants has a definite impact on the growth and development of plants at physical, physiological, biochemical, molecular, and genetic levels (Mishra et al., 2016; Chowdhury et al., 2014). The sound impact on plants is both negative and positive in terms of the development of plants. The impact of sound has varied with the composition of sound, quality, strength, duration of exposure, and obviously the specific subject, the plants being studied. However, definite consensus could be arrived at only when the minimum required systematic research is directed in the varied aspect of each specific question that needs to be answered.

The present study was directed to find the impact of devotional singing (Devotional Music) as a quantified and qualified sound stimulus for the germination of Mung bean Seeds. The rational for such a study was drawn from the review of the past scientific research as well as the importance of devotional singing and the glorification of God's name as given in Indian spiritual scriptures. Srila Vrindavandas Thakur in Chaitany Bhagbatam proclaims that lower beings who can't chant by themselves are also benefited when exposed to loud chanting of god's name by human beings (Vrindavandas, 1995). Srila Krishnadas Kabiraj in Chaitany Charitamrita writes plants and creepers were exuberant with joy and ecstasy upon the presence of the divine personality of Sri Chaitany Mahaprabhu and by his melodious chanting of god's name (Kabiraj, 1993). Sri Kripaluji Maharaj in his book Glories of Divine Name explains Astapadi (a conclave of eight verses) composed by Sri Chaitanya Maha prapbhu and writes that god's name is the very life of all transcendental knowledge. Every utterance of the divine name gives a full taste of its nectarine sweetness that swells in the heart of the chanter, like a surging ocean of everlasting Bliss and Peace (Maharaj, 2009). In Indian scripture it has been repeatedly pointed out that God's name is as powerful as God himself, God resides in each and every name of God, and Chanting of God's name aloud is beneficial to all beings. Haid & Huprikar, reported that seed germination and growth of Seedlings were affected by watering them with meditative intents. Germination of pea seeds was significantly higher when watered with intent of stimulation and germination of wheat seeds was significantly lower when watered with intent of inhibition. Biomass production of wheat seedlings on the tenth day was reported to be significantly lower when compared with untreated one. Thus, it was concluded that the meditative intent behind an action had an effect on the outcome of the action and human interaction via ceremony and rituals can affect the natural world (Haid & Huprikar, 2001). Thus, rationality rested on the hypothetical thought that when sound stimuli exhibit an impact on the plant, that impact could be regulated and enhanced by means of incorporating the essence of devotion, contemplation and power of God's name into it and then suitably manipulating the stimulus over other factors other factors of strength of music in terms of sound pressure level, duration of exposure, time of exposure etc.

MATERIALS AND METHODS

Locale of Study

Research was conducted in the serene spiritual atmosphere of Braj Gopika Seva Mission situated at Tetumberpalli, Khurda, Odisha, India in February 2022. Control condition for the experimental research was created with the construction of a polyhouse (20mt x 16mt) and ten numbers of specially designed acoustic growth chambers with an internal dimension of 40 x 40 x 72 inches. Acoustic growth chambers were fitted with speakers for audio output and connected to a control panel with music players. Acoustic growth chambers were so designed that all the treatments could be played simultaneously in a single poly house without any acoustic interference.

Selection of Seed and Growth Condition

Mung Bean seed germination test was conducted in petri dishes with 25 numbers of seeds in each petri-plates. PDM 139 (Samrat)Variety Mung bean was selected for the experiment for its availability and for the matters of an established variety for a long. Twenty-five numbers of seeds were arranged uniformly in a 5 x 5 layout on double layers of pre-soaked germination papers inside the sterilized petri-plates (Figure 1). Distilled water was used to maintain the moisture condition of the petri-plates. Seed germination parameters were recorded at an interval of 12hrs i.e., twice daily once at 5 am in the morning and another at 5 pm in the evening till 48th hours from initiation of the germination test. The petri-plates were kept in dark beyond the treatment hours.

Selection of devotional songs and formulation of treatment levels

Devotional Music was the main independent variable whose effect on dependent variables i.e., germination parameters were to be studied in the experiment. Six devotional songs were purposively selected from devotional compositions and practices of Sri Kripaluji Maharaj and soundtracks were prepared for definite time period of 10 minutes, 20 minutes, and 30 minutes each. this line may kindly be removed (it has been mentioned at a later line) Apart from being semi classical in nature, the composition had a special attribute of contemplative mediation upon God's name, glories, and pastime. Soundtracks were combined as per the playing hours and single track consisting of two songs each were prepared and recorded in separate pen-drives. Details of the devotional songs used for soundtracks are presented in Table 1. Soundtracks were played over three ranges of sound pressure levels (SPL) that is 70-80 dB(A), 80-90 dB(A) and 90-100 dB(A) and over three levels of duration of exposure i.e., 1 hour, 2 hours, and 3 hours per days and thus constituted nine experimental groups. There was one group, which was not exposed to devotional music to form a control group, making a total of ten numbers of treatment levels. Details of formulation of treatment levels are presented in Table 2. Treatments were executed thrice a day first in the early morning from 5:30 am to 6:30 am, second in the daytime from 8:00 am to 9:00 am, and third in the evening from 4:00 pm to 5:00 pm inside the acoustic growth chambers and from a height of three feet from the base where petri-plates were placed.

Research Design, Germination Tests, and Statistical Analysis

Completely Randomised Design (CRD) was employed to run the experiment with ten different levels of treatments with four replications in each. Seed germination data were recorded for each experimental unit on every 12 hours and continued for 48 hours for germination. Length of Root and Shoot was also measured and recorded at 48 hours from the initiation of the germination test. Final Germination Percentage (FGP), Mean Germination Rate (MGR) was measured in reference to the formula reported by Al-Ansari and Ksiksi (Al-Ansari & Ksiksi, 2016), Germination Index (GI) as per the formula reported by Andrew et al., (Andrew et al., 2021), Seed Vigour Index (SVI) was calculated using the formula reported by Zhu et al. (Zhu et al., 2010). Mathematical formulas used for the measurement of different germination parameters:

i.   Final Germination Percentage (FGP) = the total seed germinated at the end of a trial or experiment/ number of initial seeds used X 100

ii. Mean Germination Rate (MGR) = 1/T; where T is mean germination time (Mean germination time = Σ Fx /Σ F; where F is the number of seeds germinated on day x)

iii.   Germination Index (GI) = ∑ Gt / Dt where Gt = is the number of germinated seeds on day t and Dt = is the time corresponding to Gt in days.

iv.   Seed Vigour Index (SVI) = S × Σ (Gt / Dt); Where, S is seedling length = Root length + Shoot length and Σ (Gt / Dt) is Germination Index.

RESULTS

Effect of devotional music on germination percentage (GP)

One-way analysis of variance for final germination percentage of Mung bean seed under the treatment of devotional music (Table 3) after 48 hours of initiation of the germination test resulted with a 'F' value of 2.44, and the same was significant at p < 0.05.

Effects of devotional music on mean germination rate (MGR) and germination index (GI)

Table 3 presents that variance in the mean germination rate of Mung bean seed among the treatment groups were non-significant (F = 1.43, p = 0.22) when germination data was recorded at an interval of 12 hours. The difference in the germination index was significant with an F value of 2.19 and $p \leq 0.05$ (Table 3). Germination index was highest in T7 and lowest in T1. The germination index of T2, T4, T5, T7, T8, and T9 was higher in comparison to the control group but not statistically significant (Table 5) .

Effect of devotional music on radicle development (RD) and seed vigour index (SVI)

Analysis of variance in the radicle development among the treatment groups was highly significant with an F ratio of 6.38 and $p < 0.001$ (Table 3). Table 6 shows that mean lengths of radicle were higher in all the experimental groups (T1, T2, T3, T4, T5, T6, T7, T8, & T9) in comparison to the control group not exposed to devotional music, and was significantly higher for T2, T3, T4, T6, T8, and T9. The highest radicle development was observed in T8 with a difference of 101.1% in comparison to the control group (Table 6. Figure 2). Differences in seed vigour index (SVI) among the treatment levels were found to be highly significant with an F ratio of 4.72 and $p < .001$ (Table 3). SVI for all the experimental groups (T1, T2, T3, T4, T5, T6, T7, T8, and T9) were found to be higher in comparison to the control group and the variations were statistically significant for T3, T4, T7, T8, and T9. The highest SVI was observed in T8 with a difference of 110.48% in comparison to the control group (Table 6, Figure 3).

DISCUSSION

Results of the present study reflect that devotional music had a definite and promising effect on seed germination parameters. The final germination percentage of Mung bean seed was higher in most groups exposed to one or other levels of devotional music. The final germination percentage was highest in the group exposed to devotional music at 90-100 dB(A) for a duration of one hour per day. Chandrakala & Trivedi, (2019) reported that Music positively impacts on seed germination thorough enhancement of metabolic rate. Frequencies in musical vibration facilitate physiological activities like nutrient uptake, photosynthesis, and protein synthesis and result in the overall development of healthier plants with better yield prospects. The positive impact of green music, classical music, Gayatri mantra, Pirith and nature sounds has been observed in Wheat, spinach, horse gram, soya, and paddy. Music has immense potential in breaking seed dormancy and enhancing crop yield. Creath & Schwartz, (2004) reported that that musical sound had a statistically significant effect on numbers of okra and zucchini seed sprouted compared to untreated control as well as noise. Healing energy also had a significant effect on seed germination compared to untreated control. But no significant difference was reported between seeds exposed to noise and untreated control. Munasinghe et al., (2018) reported that a significant difference in the germination of rice was observed when seeds were treated with sound rhythm treatment at 55-60 dB(A) for 7 days in comparison to control and out of two sound rhythms used i.e., Buddhist Pirith chanting and Pop music, germination percentage was higher in Pirith treatment.

Earlier Cai et al., (2014) reported that an audible sound with an intensity of around 90 dB(A) and frequency of around 2000 Hz reduced the germination period of Mung Bean as well as improved its growth. However, in the present study, no significant difference is observed in the mean germination rate of Mung bean seed in the groups exposed to devotional music. Here it may also be speculated that the measurement of germination rate could be improved by reducing the time interval of measurement of the germination counts when the total germination period itself is short. The most relevant findings in the present study were obtained for radical development and overall seed vigour index. The most groups exposed to devotional music had significantly higher radicle growth and higher seed vigour index in comparison to the control groups. Some of the mid-experimental groups had shown higher but non-significant results which may be attributed to depression from unaccounted biotic or abiotic stress conditions. Exposure of Mung bean seeds to devotional music at 90-100 dB(A) for 2 hours per day had resulted in the highest and most significant increase in radicle development and overall seed vigour index. Chowdhury & Gupta, (2015) in their germination experiment on Cicer arietinum (chickpea) exposed to Light Indian Music, found that throughout the period of germination and development of the saplings, the ones exposed to Indian Light Music were having higher germinated seedlings and seedlings were blooming better compared to the control saplings. They also stated that soft rhythmic audible frequencies (that is music) must have affected the absorption of nutrients and formation of metabolites in the plants and thus expediting the germination of seeds, growth, and development of plants.

It may be concluded that exposure of Mung bean seeds to devotional music resulted in the higher final germination percentage and germinaiton index in comparision to the control group. An exposure of Mung bean seeds to devotional music with a sound pressure level of 90-100 dB(A) for 2hours duration resulted in the highest and most significant improvement in radicle development and seed vigour index in comparison to the control group not exposed to devotional music. Radicle development and overall seed vigour index of germinated Mung bean seeds were enhanced by 101.1% and 110.48% respectively after 48 hours of germination test. Thus it is revealed that Mung beans preferred a high sound pressure level of 90-100 dB(A) and an exposure of 1 to 2 hours per day to bring about significant improvement in the germination parameter like final germination percentage, germination index, radicle development, and overall seed vigour index. Considering seed vigour index as an overall germination parameter and based on the experimental findings related to seed vigour index, it may be generalized that for optimum germination of Mung bean seeds, the selected devotional music could be applied either for 70-80 dB(A) for 2 to 3 hours or for 80-100 dB(A) for 1 to 3 hours however for the maximization of impact of devotional music on Mung bean seed germination a sound pressure level of 90-100 dB(A) and duration of 2 hours could be preferred. The findings of the study being verymuch encourging it is being replicated over different seasons, crops and its appliction in the rest of the growth and development phases of the crop along with germination of seeds. It seems that an extended package of practice is possible towards seed germinaton, crop growth and development, and a better harvest with the application of devotional music.

ACKNOWLEDGMENT

DATA AVAILABILITY STATEMENT
This research is being carried out at the Laboratory of Braj Gopika Seva Mission, Tutumbarpalli, Pariorada, Tangi, Dist Khurda, Odisha-752023. This published article contains most of the data generated or analyzed during this study. The rest of the data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

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CONFLICT OF INTEREST
There is no conflict of interest to declare.

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Table 1 Details of devotional songs selected for the composition of devotional music

Sl. No.	Title of devotional Song	Source /or written by	Music composed by	Lead Singer	Playing Time
1	Hare Ram Mahamantra	Upanishad	Sri Kripaluji Maharaj	Sri Kripalujin Maharaj	5:30 am- 6:30 am
2	Radhe Govinda	Daina Madhuri: Radhe Govinda Geet; Sri Kripaluji	Sri Kripaluji Maharaj	Rasheswari Deviji	

		Maharaj			
3	Radhe Govinda	Braj Dham Madhuri: Radhe Govinda Geet; Sri Kripaluji Maharaj	Sri Kripaluji Maharaj	Rasheswari Deviji	8:00 am - 9:00 am
4	Hare Ram Mahamantra	Upanishad	Rasheswari Deviji	Rasheswari Deviji	
5	Sri Radha Sharanam Sri Krishna Sharanam	Sankirtan Ras Madhuri, Sri Kripaluji Maharaj	Sri Kripaluji Maharaj	Rasheswari Deviji	4:00 pm - 5:00 pm
6	Gopijana Ballava Shyam	Sri Kripaluji Maharaj	Sri Kripaluji Maharaj	Rasheswari Deviji	

Table 2 Treatment Levels and specifications

Sl. No.	Treatment Level Code (short)	Specification		Treatment Level Code (elaborate)
		SPL Range & Average (in dB(A))	DOE (in hours)	
1	T0 (C)	No Exposure (NE)	No Exposure (NE)	T0(Con)
2	T1	70-80 (75)	1	T1(75,1))
3	T2	70-80 (75)	2	T2(75,2)
4	T3	70-80 (75)	3	T3(75,3)
5	T4	80-90 (85)	1	T4(85,1)
6	T5	80-90 (85)	2	T5(85,2)
7	T6	80-90 (85)	3	T6(85,3)
8	T7	90-100 (95)	1	T7(95,1)
9	T8	90-100 (95)	2	T8(95,2)
10	T9	90-100 (95)	3	T9(95,3)

SPL: Sound Pressure Level; dB: Decibel, C: Control and Con: Contro

Table 3 One-way ANOVA for Final Germination Percentage (FGP), Mean Germination Rate (MGR), Germination Index (GI), Radicle Development (RD), and Seed Vigour Index (SVI)

Germination Parameters	Source of variance	Sum of Squares	df	Mean Square	F	p
FGP	Between	1349.89	9	149.99	2.44	0.03
	Within	1841.65	30	61.39	30	
MGR	Between	2.89e -3	9	3.21e -4	1.43	0.22
	Within	6.71e -3	30	2.24e -4		
GI	Between	32.07	9	3.56	2.19	0.05
	Within	48.73	30	1.62		
RD	Between	2.52	9	0.28	6.38	< .001
	Within	1.32	30	0.04		
SVI	Between	420.46	9	46.72	4.72	< .001
	Within	297.15	30	9.9		

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Table 4 Effect of devotional music on germination percentage of Mung bean

Treatment Levels	12 Hours			24Hours			36Hours			48Hours		
	Mean	SD	Sig.	Mean	SD	Sig.	Mean	SD	Sig.	Mean	SD	Sig.
T0(CON)	0.00	0.00	-	3	3.83	a	25	6.83	a	82	10.58	ab
T1(75,1)	0.00	0.00	-	3	6.00	a	30	9.52	a	75	3.83	b
T2(75,2)	0.00	0.00	-	9	12.81	a	32	3.27	a	83	5.03	ab
T3(75,3)	0.00	0.00	-	1	2.00	a	27	6.83	a	80	4.62	ab
T4(85,1)	0.00	0.00	-	5	7.57	a	37	3.83	a	86	11.55	ab
T5(85,2)	0.00	0.00	-	3	3.83	a	34	5.16	a	89	8.87	ab
T6(85,3)	0.00	0.00	-	2	2.31	a	26	5.16	a	82	9.52	ab
T7(95,1)	0.00	0.00	-	8	5.66	a	35	3.83	a	96	5.66	a
T8(95,2)	0.00	0.00	-	6	7.66	a	29	6.83	a	84	8.64	ab
T9(95,3)	0.00	0.00	-	6	4.00	a	25	6.83	a	85	3.83	ab

Mean germination percentage (Mean) with standard deviation (SD) at 12 hours interval, and letters in the same column (Sig.) representing significance of differences as per Tukey's HSD Test at $P < 0.05$.

Table 5 Effect of Devotional Music on Mean Germination Rate (MGR) and Germination Index (GI)

Treatment Levels	MGR			GI		
	Mean	SE	Sig.	Mean	SE	Sig.
T0(CON)	0.55	0.0078	a	11.54	0.66	ab
T1(75,1)	0.56	0.0098	a	10.88	0.38	b
T2(75,2)	0.57	0.0082	a	12.46	0.73	ab
T3(75,3)	0.55	0.0054	a	11.21	0.46	ab
T4(85,1)	0.57	0.0061	a	12.71	1.00	ab
T5(85,2)	0.56	0.0088	a	12.79	0.52	ab
T6(85,3)	0.55	0.0041	a	11.50	0.63	ab
T7(95,1)	0.56	0.0060	a	14.12	0.31	a
T8(95,2)	0.56	0.0095	a	12.21	0.92	ab
T9(95,3)	0.55	0.0069	a	12.17	0.35	ab

Mean germination rate and mean germination index (Mean) with standard error (SE), and letters in the same column (Sig.) representing significance of differences as per Tukey's HSD Test at $P < 0.05$.

Table 6 Effect of Devotional Music on Radicle Development (RD) and Seed Vigour Index of Mung Bean

Treatment Levels	RD			SVI		
	Mean	SE	Sig.	Mean	SE	Sig.
T0(CON)	0.88	0.09	c	10.21	1.45	c
T1(75,1)	1.20	0.11	bc	13.05	1.21	bc
T2(75,2)	1.52	0.10	ab	19.05	1.79	ab
T3(75,3)	1.63	0.11	ab	18.32	1.81	ab
T4(85,1)	1.48	0.10	ab	19.03	2.74	ab
T5(85,2)	1.20	0.11	bc	15.24	1.06	abc

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T6(85,3)	1.55	0.15	ab	17.62	1.28	abc
T7(95,1)	1.35	0.09	abc	19.09	1.37	ab
T8(95,2)	1.77	0.09	a	21.49	1.13	a
T9(95,3)	1.60	0.09	ab	19.45	1.15	ab

Mean radical development and mean seed vigour index (Mean) with standard error (SE) and letters in the same column (Sig.) representing significance of differences as per Tukey's HSD Test at $P < 0.05$.
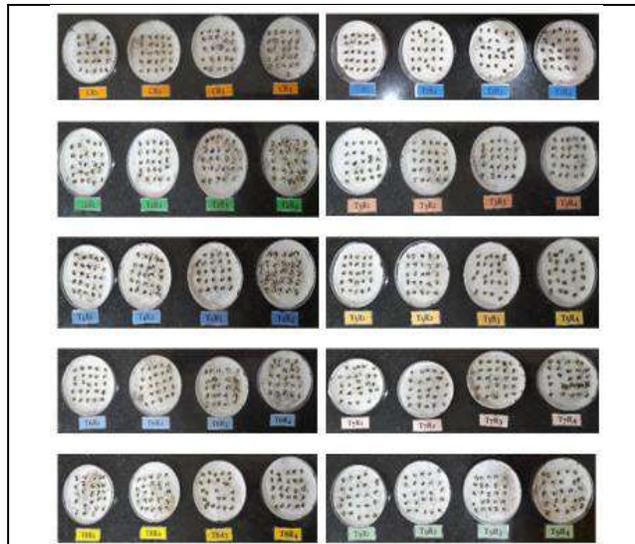
Fig. 1 Twenty-five numbers of Mung bean seeds arranged in each petri dishes in 5x5 layouts over double layers of water-soaked seed germination papers for ten different Treatment Levels with four numbers of replication each.
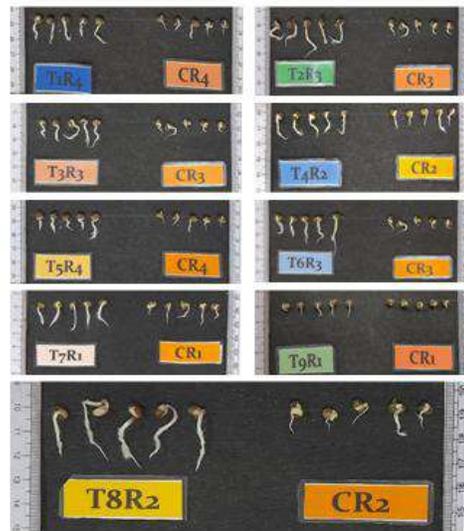
Fig. 2 Comparative growth of radicle in different experimental units exposed to devotional music against control units not exposed to devotional music
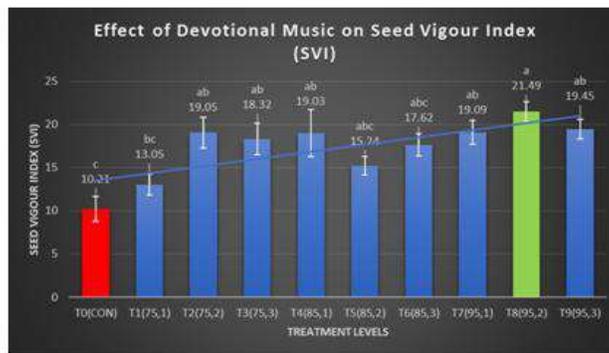
Fig. 3. Mean Seed vigour index of Mung bean (*Vigna radiata*) seeds 48 hours after germination test under nine experimental groups and one control group (n=4). Different letters on each bar represent the significance of the difference in comparison to the other treatment groups at $P < 0.05$.

RESEARCH ARTICLE

An Eco Friendly and Holistic Approach to Assess the Efficacy of Root and Leaf Extracts of *Withania somnifera* against MCF -7 Breast Cancer Cell Line

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ABSTRACT

Cancer is a dreadful disease. Conventional methods used for the treatment of cancer is painful it causes physical, and mental effects on patient's health and could be toxic and hazardous in nature. Plants are considered to be safer and effective for the treatment as it contains natural, non-toxic, biologically active compounds which are safer to mankind. *Withania somnifera* is an important medicinal plant which is widely cultivated in various parts of India. Several studies indicate that *Withania somnifera* possess anti cancerous activity. In this present study four plant extracts- leaves ethanol (LE), leaf aqueous (LW), root aqueous (RW) and root ethanol (RE) extracts were used against Vero cell linage to check the cell cytotoxicity effects. MCF 7 Breast cancer cell lines were used to check the efficacy of *Withania somnifera* against breast cancer cell lines. Leaf ethanolic extract lysed 21.31% -81.70 % of MCF7 Breast cancer cells. LW lysed 50.79 %- 88.41% of MCF 7 cancer cells the other hand root extracts of *Withania somnifera* – RE lysed 7.86%-60% of MCF 7 cancer cells and RW lysed 9.02%- 66.43% of MCF 7 cancer cells. Results indicated that the *Withania somnifera* plant contained certain potential molecules to cure breast cancer without causing any harmful side effect on the growth of normal cells. This anti-cancer study encourages us to use plant-based medicines for the treatment of breast cancer, other cancer treatments.

Keywords: *Withania somnifera*, MCF 7 Breast cancer, Anticancer activity

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INTRODUCTION

Cancer is a group of diseases which involves abnormal and uncontrolled growth of cells with the potential to spread to other parts of body (1, 2).It also affects the functioning of various parts of the body. The most common types of cancer in males are: lung cancer, prostate cancer, and colorectal cancer..Breast, lung and cervical cancer are very common in females (3). Cancer is often treated by chemo and radiation therapy which causes pain, psychological distress and various side effect such as hair fall, skin problems , patches, itchiness etc. Various medicinal plants contain anti cancer activities. Indian ginseng – *Withania somnifera* also known as Ashwagandha, Asgandh,   and winter cherry, belongs to the plant family Solanaceae (4). It grows in countries such as India, Nepal, Bangladesh, Sri Lanka, Pakistan, Afghanistan, parts of the Middle-East, Africa, Canary Islands and Spain (5).It is an important medicinal Kharif crop widely cultivated in various parts of India such as Gwalior, Guna, Jabalpur, Narsinghpur, Neemuch, Bhind, Mandasaur (Madhya Pradesh), Anand, Vadodara, (Gujrat), Udaipur,Nagour and Jodhpur (Rajasthan) and several other parts of Madhya Pradesh, Uttar Pradesh, Rajasthan, Gujarat, Punjab, Haryana and Maharashtra. This crop does not require high amount of water and can be easily cultivated in drysoil, sandy loam, and at tropical region at pH 7.5 -8. It grows up to 1.5 meters in height (6). Ashwagandha roots are an important part in the medicinal system of Ayurveda for over 3000 years in the preparation of liver tonic and analgesics. Some research work confirms that the whole plant and plant parts specifically root and leaf extracts have very important medicinal properties like – neurasthenic, astringent, anti-inflammatory, antidepressant, anti-stress and anti-oxidant activity (7). Additionally this plant was effective as an anti-tumour, anti-cancer and immune modulating activity (8).

Root contains Glyco with anolides which were anxiolytic and antidepressant in nature (9). *Withania somnifera* extracts were found to be more effective than ranitidine to treat stress induced gastric ulcer (10). Extracts of *Withania somnifera* was found to inhibit the haloperidol or respine induced catalepsy which showed its potential to treat Parkinson disease(11) Extracts of *Withania somnifera* has anti venom property (12), anti inflammatory (13), antiangiogenic (14) effects. Root extracts of *Withania somnifera* has been used by the major ayurvedic medicine companies as a diuretic, hypo cholesterolemic and hypo glycaemic agent (15). *Withania somnifera* extract have potential to stop the growth of cancer cell and also it produces reactive oxygen species so that cell can perform apoptosis (16).*Withania somnifera* extract does not affect the functioning of normal and healthy cells. In some in vivo studies it is found that the extract of *Withania somnifera* has potential to induce the programmed cell death of various cancer cells and modulate immune regulation (17, 18, and 19).*Withania somnifera* extract can reduce the succinate dehydrogenase activity, inhibits 35S ribosome incorporation and significantly increases Mg^{2+} activity in granulomas (20) which indicates the potential of *Withania somnifera* extract against tumour cells. Several studies associated the anti cancer effect of *Withania somnifera* (Ashwagandha) is due to the presence of bioactive compound Called With enolides. This was isolated from the leaves sample of *Withania somnifera* and it was called as With enolide A (4β,5β,6β,22R-4,27-dihydroxy-5,6-22,26-diepoxyergosta- 2, 24-diene-1,26-dione) (21).Withanolide A possesses antistress (22), antioxidant (23), immunomodulatory activity and can increase the WBC count , alpha esterase (24)and anti angiogenesis activity (25). Several studies indicates that Withenolide A has pharmacological potential to affect various cell activities like, cell motility, survival ability, proliferation, metastasis and chemo sensitization towards drug resistance *in vitro* and *in vivo*, which indicates that Withenolide A is a reliable anti cancer phytochemical (26, 27).

MATERIAL AND METHOD

Aqueous and ethanolic root and leaves extracts of *Withania somnifera*, 96 well micro plates, conical flasks, MTT solution, Phosphate buffer Saline (PBS- pH 7.4), DMSO, test tubes, conical flasks, micropipettes, micropipette tips, Digital inverted Microscope, Spectrophotometer and CO_2 Incubator.
Cytotoxicity effect

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Ethanolic and aqueous extracts of root and leaves were prepared by Soxhlet distillation. The sample was allowed to cool and dry for 7-8 days at room temperature. After the evaporation of solvent dry plant extract was obtained. This crude extract was used against the Vero Cell lines and MCF 7 Breast cancer cell lines to check the anti-cancer activity of other compounds present in *Withania somnifera.* Four samples namely- root ethanolic (RE), root aqueous (RW), leaf ethanolic (LE) and leaf aqueous (LW) extracts were selected for the study of cytotoxic effect against MCF -7 breast cancer cell lines and Vero cell lines by using MTT assay (3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyltetrazolium bromide assay (34). 1×10^6 cells/well concentration of cells were seeded in 96 well micro plates in sterile conditions then incubated at 37°C for 48 h in 5% CO_2 incubator as it provided optimum conditions for the growth of mammalian cell lines. After 48 hrs cells confluence was checked. After observing the 70-80% confluence, the culture medium was replaced. The cells were treated with different concentrations- 50μg/ml, 100 μg/ml, 150 μg/ml and 200 μg/ml of samples and incubated for 24 hrs in optimum conditions. After the 24 hrs morphological changes of untreated (Control) cells and treated cells were noted under the digital inverted microscope (20 X magnifications) and photographed. The cells were then washed with Phosphate Buffer Saline (PBS, pH -7.4). 20 μl of MTT solution (Concentration- 5 mg/ml in PBS) was added in each well. Then the plates were kept in dark for 2 hrs at room temperature (24°C). Formazan crystals were dissolved in 100 μl DMSO and the absorbance was recorded at 570nm. Cell viability percentage (%) was calculated by using the formula-
Cell viability (%) = (Absorbance of sample/Absorbance of control) X 100.

RESULT AND DISCUSSION

Different concentrations-50 **μ**g/ml, 100 **μ**g/ml, 150 **μ**g/ml, 200 **μ**g/ml of all 4 samples namely leaf ethanolic (LE), leaf aqueous (LW), root ethanolic (RE) and root aqueous (RE) used against Vero cell lines showed nil or negligible cytotoxic effect at 50 **μ**g/ml, 100 **μ**g/ml and 150 **μ**g/ml. Leaf aqueous extract (LW) showed 91.50% viability at 50 **μ**g/ml, 75.67% cells were viable at 100 **μ**g/ml, 55.165% cells were viable at 150 **μ**g/ml concentration (Graph 1). Leaf ethanolic extract (LE) showed 93.81% cell viability at 50 **μ**g/ml , 77 .89% cells viability at 100 **μ**g/ml, and 59.81% cells were viable at 150 **μ**g/ml concentration(Graph 2). Against root ethanolic extract (RE) 94.41% cells were viable at 50 **μ**g/ml, 76.35% cells were viable at 100 **μ**g/ml, and 58.73% cells were viable at 150 **μ**g/ml concentration (Graph 3). Against root aqueous (RW) 90.752% cells were viable at 50 **μ**g/ml, 71.89% cells were viable at 100 **μ**g/ml and 52.37% cells were viable at 150 g/ml concentration (Graph 4). **Against MCF-7** breast cancer cell lines- Various concentrations- 50 g/ml, 100 g/ml, 150 g/ml, 200 g/ml of leaf ethanolic (LE), leaf aqueous (LW), root ethanolic (RE) and root aqueous (RW) extracts showed significant efficacy against the MCF-7 breast cancer lines. Images clearly indicate that all 4 extracts LE, LW, RE and RW can control / restrict the growth of breast cancer cell lines. Leaf ethanolic (LE), extract showed 78.68% viability at 50 g/ml, which means 21.32% cells lysed at 50 g/ml, 54.851% viability (45.15% lysed of MCF 7 breast cancer cells) at 100 g/ml, 32.723% viability shows the lysed of 67.277% of MCF 7 breast cancer cells lysed at 150 g/ml, only 18.297% viability recorded (lysed/ reduction of 81.297% of MCF7 breast cancer cell) at 200 g/ml concentration (Graph 6).

Leaf aqueous (LW) extract of *Withania somnifera* showed 49.202% viability (50.798% lysed of MCF 7 breast cancer cells) at 50 g/ml concentration, 32.035% viability of cancer cells showed the lysed of 68% of MCF 7 breast cancer cells at 100 g/ml concentration, 15.431 % viability showed the lysed of 84.569% MCF 7 breast cancer cells at 150 g/ml concentration, 11.8% viability proved the reduction of 88.41% of MCF 7 Breast cancer cell line (Graph 7) which is highest among all four extracts (Graph 10). On the other hand root extracts also showed significant effects. Against root ethanolic (RE) extract of *Withania somnifera* – 92.133% viability showed the lysed of 7.87% of MCF 7 breast cancer cells at 50 g/ml, 76.317 % viability showed the 23.683% of lysed of MCF 7 breast cancer cells at 100 g/ml concentration, 58.855% viability showed the lysed of 41.145% MCF 7 breast cancer cells at 150 g/ml, 39.99% viability of cells showed the lysed of 60% MCF 7breast cancer cells at 200 g/ml concentration(Graph 8). Against Root aqueous extract 90.975% viability showed 9% lysed of MCF 7 breast cancer cells at 50 g/ml concentration, 78.599% viability showed 21.40% reduction/ lysed of MCF 7 breast cancer cells at 100 g/ml concentration, 55.006%

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viability showed 45% reduction of MCF 7 breast cancer cell at 150□g/ml concentration, 33.562% viability of cells proved the reduction / lysed of 66.438% of breast cancer cell line (Graph 9).

CONCLUSION

Leaf ethanolic extract lysed 21.31% -81.70 % of MCF7 Breast cancer cells , LW lysed 50.79 %- 88.41% of MCF 7 cancer cells the other hand root extracts of *Withania somnifera* – RE lysed 7.86%-60% of MCF 7 cancer cells and RW lysed 9.02%- 66.43% of MCF 7 cancer cells. Previous investigations also support these results and show the efficacy of *Withania somnifera* extracts against breast cancer cell lines. It boosts immunity of females, can prevent the tumour development and can be used for the treatment of breast cancer disease. Present investigation will encourage the use of plant based natural substances to cure cancer and other associated diseases.

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Table 1 - Efficacy of various crude extracts of *Withania somnifera* at different concentrations against Vero cell line

S.No.	Extract name	Concentration of extract	Percentage (%) viability of Vero cell line	Average absorbance ±SD	% Lysed of Vero cell line
1	Leaf Ethanolic (LE)	50	93.82	0.75 ±0.009	6.18
2	Leaf Ethanolic (LE)	100	77.89	0.63 ± 0.012	22.11
3	Leaf Ethanolic (LE)	150	59.81	0.48 ± 0.007	40.19
4	Leaf Ethanolic (LE)	200	28.20	0.23 ± 0.003	71.79
5	Leaf Aqueous (LW)	50	91.50	0.76 ± 0.005	8.50
6	Leaf Aqueous (LW)	100	75.67	0.63 ±0.009	24.33
7	Leaf Aqueous (LW)	150	55.17	0.46 ±0.007	44.83
8	Leaf Aqueous (LW)	200	25.05	0.21 ± 0.008	74.95
9	Root Ethanolic (RE)	50	94.40	0.74 ± 0.006	5.59

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10	Root Ethanolic (RE)	100	76.35	0.60 ± 0.005	23.64
11	Root Ethanolic (RE)	150	58.73	0.46 ± 0.008	41.27
12	Root Ethanolic (RE)	200	27.91	0.22 ± 0.008	72.087
13	Root Aqueous (RW)	50	90.75	0.65 ±0.006	9.25
14	Root Aqueous (RW)	100	71.89	0.51 ± 0.006	28.11
15	Root Aqueous (RW)	150	52.37	0.37 ±0.006	47.63
16	Root Aqueous (RW)	200	23.14	0.17 ±0.008	76.86

Table 2 - Efficacy of various crude extracts of *Withania somnifera* at different concentrations against MCF 7 Breast cancer cell line.

S. No.	Extract name	Concentration of extract	Percentage (%) viability of MCF 7 Breast cancer cell line	Average absorbance ±SD	% Lysed of MCF 7 Breast cancer cell line
1	Leaf Ethanolic (LE)	50	78.68	0.62 ± 0.011	21.32
2	Leaf Ethanolic (LE)	100	54.85	0.43 ± 0.020	45.15
3	Leaf Ethanolic (LE)	150	32.72	0.26 ±0.010	67.28
4	Leaf Ethanolic (LE)	200	18.30	0.14 ±0.019	81.70
5	Leaf Aqueous (LW)	50	49.20	0.35 ± 0.0083	50.80
6	Leaf Aqueous (LW)	100	32.03	0.23 ± 0.00873	67.96
7	Leaf Aqueous (LW)	150	15.43	0.11±0.0092	84.57
8	Leaf Aqueous (LW)	200	11.58	0.082 ± 0.0120	88.41
9	Root Ethanolic (RE)	50	92.13	0.75 ± 0.0090	7.87
10	Root Ethanolic	100	76.31	0.62 ± 0.0153	23.68

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	(RE)				
11	Root Ethanolic (RE)	150	58.85	0.48±0.0110	41.14
12	Root Ethanolic (RE)	200	39.99	0.32 ± 0.0150	60.00
13	Root Aqueous (RW)	50	90.97	0.70±0.0083	9.024
14	Root Aqueous (RW)	100	78.60	0.61 ±0.0145	21.40
15	Root Aqueous (RW)	150	55.00	0.43 ±0.0092	44.99
16	Root Aqueous (RW)	200	33.56	0.26 ± 0.0132	66.43

RESEARCH ARTICLE

Quality Evaluation of Voice Signal Based on QMF and Source Filter Model using MAT LAB - Simulink

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ABSTRACT

Voice-coding has been foremost problem in the vicinity of next generation modern wireless communication and digital audio as well as voice processing. voice-coding is the art of renovating the voice signal in a more dense form, which can be broadcasted with a small numbers of binary digits. Linear Predictive Coding (LP) is an extensively utilized technique in audio as well as Voice signal processing. It has create particular use in voice-signal Compression, allowing for very high density rate. This Paper expose the novel approach based on QMF and Source filter Model where QMF filter employed to break up the wideband speech into LF & HF part and processing it individually so that without wideband(WB) coder at source side the near perfect original WB voice has been recovered. Subsequently obtained voice signal can be further processed through source filter model for evaluating signal based on voice quality. From the obtained voice signal at the time varying synthesis filter it can be concluded that source filter model can requires fewer number of bits compared to whole original voice signal transmission at the cost of degradation in voice quality. One can notify the significant changes in original voice quality by observing the spectrogram of voice signal. Less number of bit representation can help in reducing the storage requirement and bandwidth (BW).

Keywords: Quadrature Mirror Filter, Wideband, Public switched telephone systems, reflection co-efficient.

INTRODUCTION

Wireless communication is an emerging field which has seen enormous growth in last few years. The huge uptake rate of mobile phone technology and exponential growth of the Internet of Things have resulted in the increasing demand of the Voice coder which can compress the data & transmit it with a fewest number of bits. As far as Growth in Next generation modern wireless technology connected with the up gradation in voice coder, 4th & 5th generation wireless system is popular in world market due to their low bit rate voice coder only. In digital telecommunication systems it is always necessity to transmit voice signal (speech signal) strongly[1,12].Public switched telephone systems (PSTN) shrivel the bandwidth (B.W.) of the transmitted voice signal from an effective frequency range of 50 Hz to 7 KHz to the range of 50 Hz to 3.4 KHz. The condensed BW leads to a slim and muffled sound. As per the recommendation of ITU-T conducted Listening tests speech BW affects the perceived voice quality[2]. Introduction of wideband communication system aggravated the transmission of wideband signal having cutoff frequency of at least 7 kHz for improved voice quality in form of the intelligibility and naturalness. the restricted access problem in the employment of Wideband coders and communication is up gradation of current NB coders and transmission to WB system where hardware and software up gradation and compatibility is forever a major issue[13].

Better voice signal (speech signal) quality performance offered by Wideband coders, at rest hasty alternate of complete NB coding and transmission systems is not sufficient due to remarkable infrastructure expenses incurred to network operators and also for the customers who wants to make use of the system. One decade has been departed been departed for changeover existing NB systems to fully WB compatible systems. Terminal and network must be changed to make NB system compatible to WB system. During that span novel approach have been urbanized urbanized to widen the Narrowband BW of speech (voice) signal at handset end (receiver) for humanizing final voice(speech) quality[3]. Bandwidth extension (BWE) system for speech signals is a compelling, reasonable option to acquire wideband speech with excellent quality sound for the existing wireless communication infrastructures, like PSTN and global system for mobile communication (GSM)[13]. Bandwidth extension techniques of voice(speech) are mostly categorized into two classes. In one class the missing frequency component is achieved from the available NB speech component with not necessary to transmit data about the stolen frequencies because of the expansion is wholly w.r.t. NB speech signal, these techniques can be done at the enviable end of the channel.

The other depends on data hide method. The greater part of the prior strategy make WB speech by source filter model (LP) demonstrate [4],excitation signal and LPC coefficient for spectral envelope. The BWE techniques of speech in view of data hiding method insert High frequency segments data into the NB speech bit stream, and then at the user end terminal the WB speech is recuperated w.r.t. High frequency data. The techniques are without charge and can be utilized with any NB speech codecs. A limitation of BWE technique with side data is that their abuse requires that a similar technique is bolstered at the two ends of the transmission line [5,6]. Then again, the execution of such techniques can clearly be better than that of prior extension techniques. In this paper QMF and source filter model based bandwidth extension and quality evaluation of speech signal is carried out. In QMF's, the whole signal could be partitioned into two parts meaning that full band voice signal(speech signal) is partitioned into two half band signal. The extraordinary properties of these channels permitted the half band signals to be sampled at half rate to the original sampled rate and then reproduced effectively. This disclosure offered ascend to an entire generation of speech sub band coders. the obtained speech signal can be further processed through source filter model for evaluating the performance of the speech signal in terms of speech quality, frequency domain spectrogram etc.. to judge the speech signal compression. This paper is organized as follows:-Sect.2. describes the problem. Sect.3. thrash out about theory related to novel approach for bandwidth extension based on QMF and source filter model(SFM). The results obtained through series of simulation in MATLAB has been reported in this section. Finally the concluding remarks are given in Sect.4.

PROBLEM DEFINITION

In recent scenario of technological advancement in modern wireless communication systems, surrounded by plentiful reasons for on the whole degradation of recovered voice signal quality at receiver end, major reasons to be considered is the utilization of Narrow Band (NB) end devices and NB transmission medium supporting BW of 300 Hz-3.4KHz. The intrinsic negative aspect of such voice signal is that sounds quality appeared is stifled and thin because of absence of HB spectral components[1].The limited frequency band trim down both quality and intelligibility of speech due to the missing high frequency components that are significant cues especially inconsonant sounds[6]. Factors which may affect the quality of recovered voice signals(speech signals) are limited acoustic bandwidth, acoustic background noise, quantization noise due to source coding and residual error after channel decoding. Fricatives like /s/, /z/ and partly /f/, /S/, /Z/ are not easy to recover using only NB speech as considerable energy of these fricatives are located in Extension band (HF band) thus restrict quality of recovered voice(speech) signal[9].To get better quality, intelligibility of speech(voice) degraded by narrow bandwidth(NB),researchers have almost concentrate on top of standardize the telephonic networks by introducing WB (50-7KHz) voice(speech) encoder. WB speech transmission requires the transmission network and terminal devices at both ends to be upgraded to the WB that turns out to be time-consuming[7].Software/hardware upgradation, compatibility are major issues to abruptly substitute entire existing NB coding system.[8].This paper focus on the novel approach based on QMF filter to separate out the wideband speech into LF and HF part and processing it individually so that without wideband coder at transmitter side the near perfect original wideband speech has been recovered and the obtained speech signal can be further processed through source filter model for evaluating the performance of the speech signal.

BWE BASED ON QMF AND EVALUATION OF VOICE SIGNAL THROUGH SFM

The BWE system based on QMF is shown in Fig. 1,which containing Hi band and low band analysis sub-band coder, down sampler, G.711 encoder at transmitting terminal, G.711 decoder, up sampler, Hi band and low band synthesis sub and coder. At user end terminal, from Fig. 1, to start with, original WB speech signal through 16 KHz sampling frequency is place into two channel QMF bank [10]. Then channel bank's outcomes are decimated by two. In this way both HF and LF segments through 8 KHz sampling frequency are acquired. Next, LF parts are encoded by the NB encoder which is G.711 encoder[11]. the HF part is transmitted without changes at the transmitter side to the receiver through transmission channel. At the user end, NB speech signal is decoded through NB speech decoder and HF is restored as it is. Finally the signal is synthesized by Hi band and low band synthesis sub-band coder and near perfect reconstruction of original signal is obtained at output which can be observed on spectrum analyzer and listen speech file played on Audio device writer. Performance evaluation of speech signal based on Source filter model, Source Filter model based Analysis Source Filter model based Synthesis are shown in Fig. 2, Fig. 3 and Fig.4 respectively.

As shown in Fig.2 the original speech signal is pass through LPC analysis block to separate out LPC co-efficient and residual component which is further processed by bit stream quantization to make quantized signal level which is processed by LPC synthesizer to make compressed original speech signal[14].As exposed in Fig.3.the speech signal (wave file) is break up into frames of size 20 ms (160 samples), with an overlap of 10 ms (80 samples). Each frame is windowed using a Hamming window. Then Eleventh-order autocorrelation coefficients are initiate, and then the reflection coefficients are calculated from the autocorrelation coefficients using the Levinson approach. The original speech signal is conceded via an analysis filter, that is an all-zero filter with coefficients as the reflection coefficients obtained above. The output of the filter is the residual signal. As revealed in Fig. 4 LPC Synthesizer that is time varying filter found in the receiver section of the system, reconstruct the original signal using the reflection coefficients and the residual signal. This is played through the Audio player. Fig. 5 & 6 shows the input and output time domain waveform of the wave file "OMSHRI GANESHAY NAMAH". Fig. 7 & 8 shows the input and output frequency domain waveform of the wave file "OM SHRI GANESHAY NAMAH". from the waveforms it is clearly

identified that the signal looks very different in time domain but in frequency domain it is looks like same because of the nearly same power distribution at the same frequency will be observed in the waveform which can be heard on audio player. the result displayed on each stage by using spectrum analyzer or time scope or display is taking some time because in our simulation 1536 samples need to be updated for displaying result at each stage once the required number of samples are acquired there is no issue regarding results. One other noticeable remarks from viewing various time/frequency domain waveform is that at each stage of the source filter model approach the sampling frequency is changing so variation in signal waveform can be obtained. Pre-Emphasized Speech signal, hamming windowed Speech signal, LPC analyzer output, LPC synthesizer output & Auto cor-relation co-efficient (ACF), Reflection co-efficient (RC) and LPC co-efficient are depicted as shown in Fig. 9 to 13. The values of Reflection co-efficient (RC) must not exceeds 1 for stability point of view as depicted in Fig.13.

COCLUSION

The Novel approach presented in the paper can attain the required Bandwidth extension to improve stifled and thin speech quality. without wideband coder at transmitter side the near perfect original wideband speech has been recovered and the obtained speech signal can be further processed through source filter model intended for evaluating signal based on speech quality, frequency domain spectrogram etc.. to judge the speech signal compression. by employing source filter model in place of 160 samples only 10 LPC co-efficient, 01 bit for voiced/Unvoiced Design 01 Bit- for gain are needed so large signal compression achieved which helpful in memory and storage requirement. due to technological advancement the author is target to develop MATLAB code for supre-wideband signal from wideband signal and compare the performance analysis of the signal with Real super wideband EVS coder and AMR-WB coder. Also the stability consideration of RC co-efficient is the targeted by author for future work.

ACKNOWLEDGMENT

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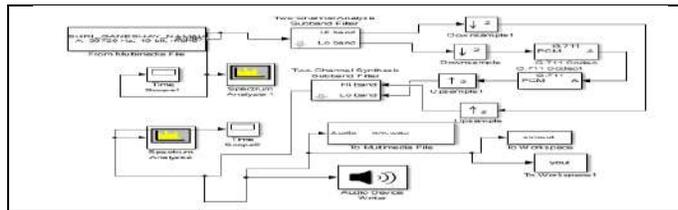
Fig.1 Bandwidth extension based on QMF
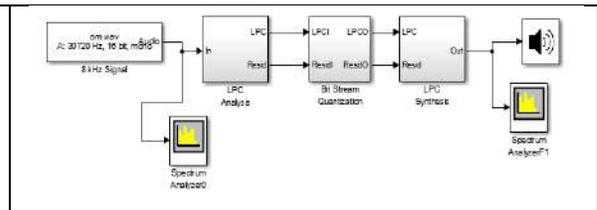
Fig. 2 Performance evaluation of Voice signal based on SFM
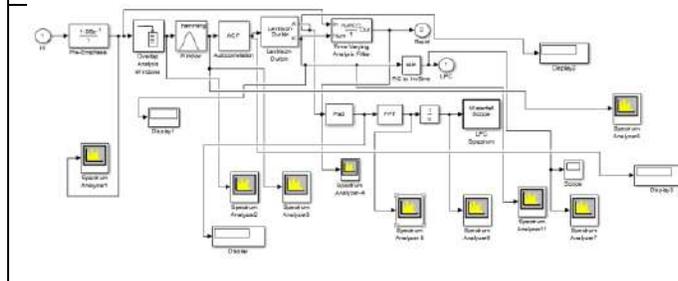
Fig. 3 Source Filter model based Analysis
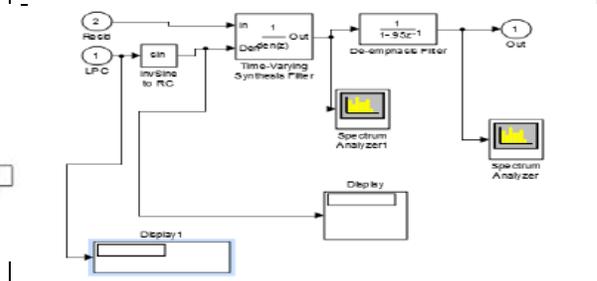
Fig. 4 Source Filter model based Synthesis
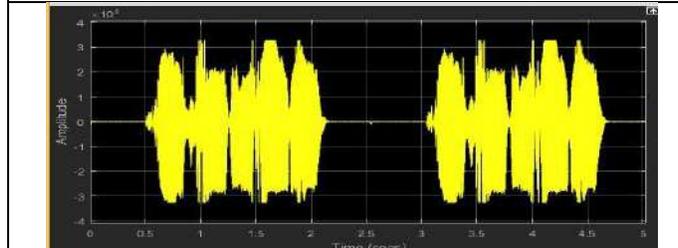
Fig.5 Input time domain waveform of wave file "OM SHRI GANESHAY NAMAH"
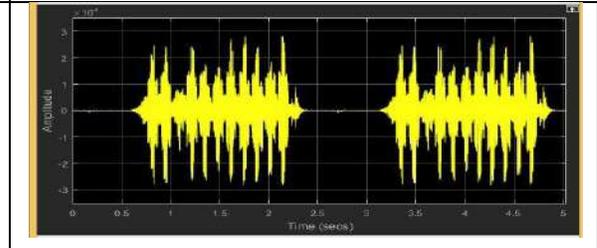
Fig. 6 Output time domain waveform of wave file "OM SHRI GANESHAY NAMAH"
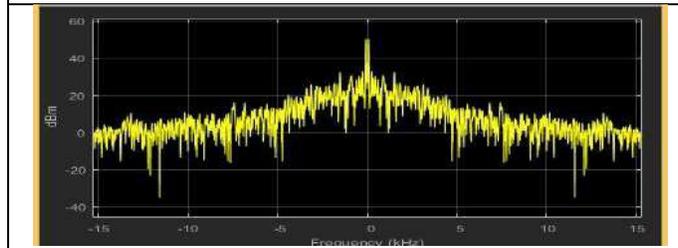
Fig. 7 Input frequency domain waveform of wave file "OM SHRI GANESHAY NAMAH"
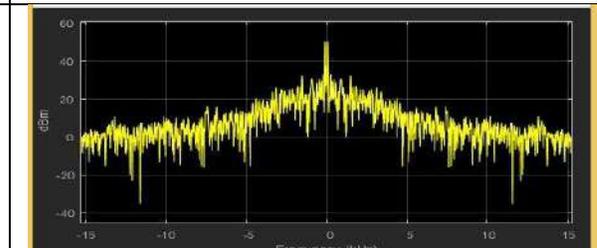
Fig. 8 Output frequency domain waveform of Wave file "OM SHRI GANESHAY NAMAH"
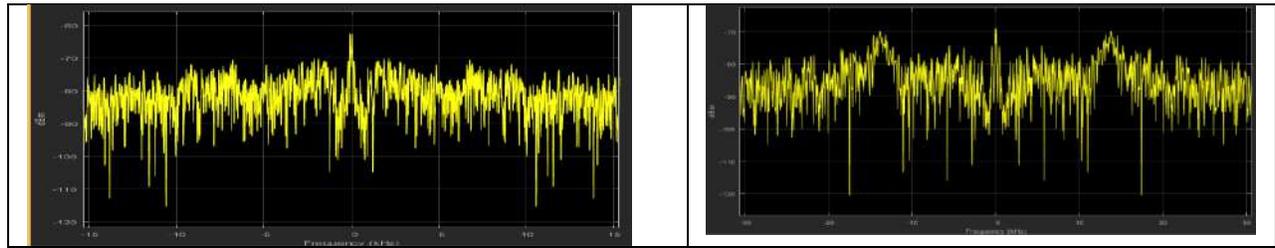
Fig.9 Pre-Emphasized Speech signal

Fig.10 Hamming windowed Speech signal
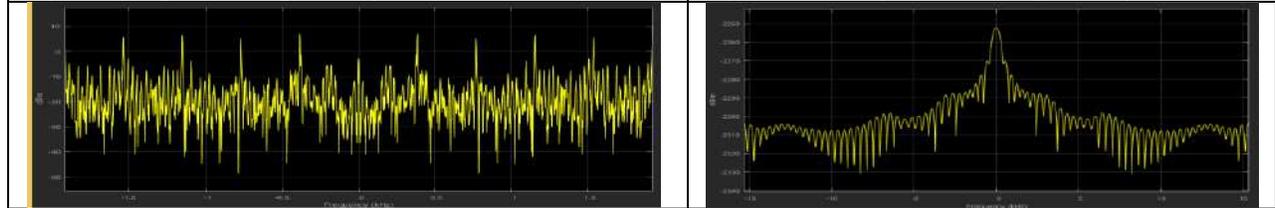
Fig. 11 LPC analyzer output

Fig.12. LPC synthesizer output
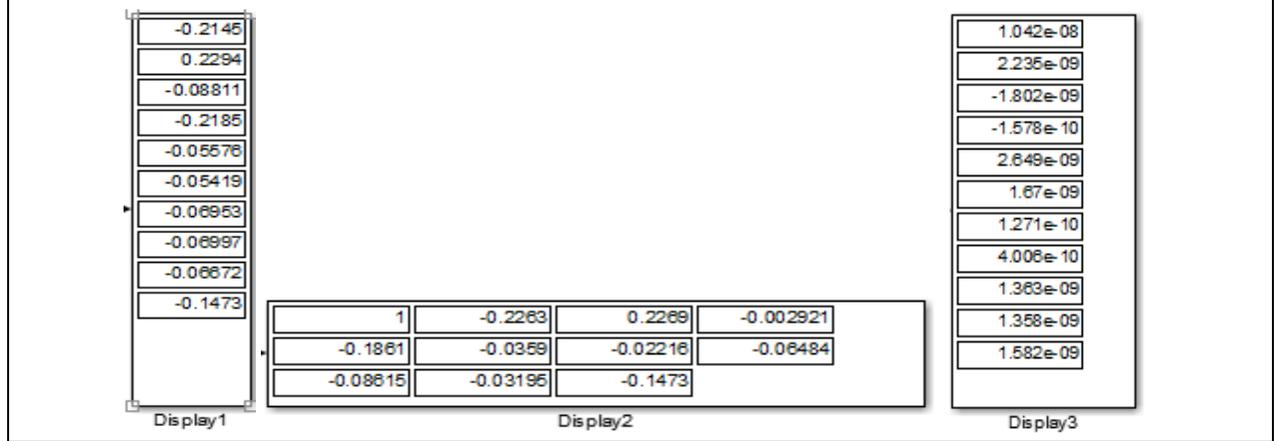
Fig.13.Auto cor-relation co-efficient (ACF), Reflection co-efficient (RC) and LPC co-efficient

RESEARCH ARTICLE

Evaluation of Binding Affinity of Seenthil Kudineer Ingredients with Enzyme RNA-Dependent RNA Polymerase of Dengue Virus through Molecular Docking *In-silico* Approach

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ABSTRACT

This study aims to detect the bioactive components in the Seenthil kudineer that have the therapeutic potential to combat one of the enzymes present in the dengue virus. The protein to be targeted has been chosen from the protein data bank as NS5 RNA-dependent RNA polymerase. According to Siddha literature, numerous fevers that cause mild to moderate acute hemorrhagic signs are managed with *Seenthil Kudineer*, a conventional Siddha formulation. Objective: This research article attempts to carry out the molecular docking analysis of the chosen herbal bioactive components against the target enzyme Tyrosinase in Vitiligo. Methods: Docking calculations were done for the obtainedbio-active compounds, including Tinosporide from *Tinospora cordifolia* (Thunb.) Miers, Santalic acid from *Santalum album (Linn.)*, Gingerenone-Afrom *Zingiber officinale* (Roscoe), Vasicin one from *Sida cordifolia* (Linn.), Beta-santalol from *Cyperus rotundus* (Linn.), Rutin&Geniposide from *Hedyotis corymbosa* (Linn.), Thymol from *Plectranthus vettiveriodes* (Jacob)and Ascorbic acid and Gamma-Himachalene from *Chrysopogon zizanioides* (Linn.)against Tyrosinase (PDB)-1WX3, the intended protein.The calculated energy of binding appeared to be a magnitude in kcal/mol as follows: Rutin -10.28, Geniposide-7.90, Gingerenone-7.14, Santalic acid-

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6.09, Gamma Himachalene-5.91, Beta-Santalol-5.80, Tinosporide-5.43, Ascorbic acid-5.32, Vasicinone-5.12 and Thymol-4.22, respectively, towards the target PDB-2J7U.Conclusion: The exploratory findings from this study corroborate the bioactive molecules present in the ingredients of Seenthil Kudineer, which have remarkable anti-viral activity for combating the dengue virus.

Keywords: *Seenthil Kudineer*, Dengue, Instrumental analysis, Molecular docking, Siddha medicine, Anti-viral

INTRODUCTION

Dengue is a common hemorrhagic viral illness that results in severe complications if not treated properly. Early diagnosis and preventive methods only protect human society from these most dangerous vector-borne illnesses. Every year, more than 1,00,000 infections and around 200 to 400 deaths occur due to this dengue virus throughout India [1]. In 2017, around 1,88,000 infections and 300 deaths were recorded by the NVBDCP. Being a multi systemic illness, the signs and symptoms of dengue progress within 1-2 days, which may result in death due to dengue shock syndrome arising from thrombocytopenia [2]. There are so many active enzymes present in the dengue virus that are capable of adhering to the host cells and causing the disease [3,4]. Among those enzymes, NS5 RNA-dependent RNA polymerase (2J7U) [5] was selected as the target to find out the interaction between the bioactive components of the ingredients of the decoction. In Siddha medicine, the *Pithasuram* mentioned in the classical Siddha textbook, *Siddha maruthuvam*-Pothu can be correlated with dengue fever [6]. So this preliminary docking study is needed to evaluate the antiviral properties of the ingredients of Seenthil kudineer, which is indicated in *Gunapadam Mooligai Vaguppu* for the treatment of *pitha suram* [7].

MATERIALS AND METHODS
Review about the drug - *Seenthil Kudineer* [7]
The drug has the following 8 herbals such as *Tinospora cordifolia* (Thunb.) Miers *(Seenthil), Santalum album (Linn.)(Santhanam),Zingiber officinale* (Roscoe.)*(Chukku), Sida cordifolia* (Linn.) *(Sittramutti), Cyperus rotundus* (Linn.) *(Korai kizhangu), Hedyotis corymbosa* (Linn.) *(Parpadagam), Plectranthus vettiveriodes* (Jacob) *(Vilamichuver) and Chrysopogon zizanioide* (Linn.)*(Veetiver).* The selected compounds from each herb were tabulated in **Table.1**

Objective of the study
The research's main objective is to track down prospective lead compounds that may adhere to essential bioactive amino acid residues.

Preparation of the Target protein-PDB ID: 2J7U [16,17]
The structure of the target protein PDB ID: 2J7U (Fig. 1), was extracted from the data bank for protein and performed a cleansing process. The Auto dock technique investigated each of the lead molecule configurations in relationship with the selected protein, and the most effective docking posture was determined considering the interaction findings from the study.

Preparation of the Ligand [18]
The herbs were selected as per the Siddha classical textbook *Gunapadam mooligai vaguppu* with the indication for *Pitha suram* (Dengue fever). The following 8 herbs were included by reviewing the previous research articles in Table 1 which had showed their bio-active molecules such asTinosporidefrom*Tinospora cordifolia* (Thunb.) Miers, Santalic acidfrom *Santalum album (Linn.),* Gingerenone-Afrom *Zingiber officinale* (Roscoe), Vasicinonefrom *Sida cordifolia* (Linn.), Beta-santalol from *Cyperus rotundus* (Linn.), Rutin & Geniposide from *Hedyotis corymbosa* (Linn.), Thymol

from *Plectranthus vettiveriodes* (Jacob)and Ascorbic acid and Gamma-Himachalene from *Chrysopogon zizanioides* (Linn.). They were retrieved from a systematic literature review and IMPAAT database.

The objective and methodology of Molecular Docking [19,20]

The binding of phyto chemicals with the core amino acids (Ser-710, Arg-737and Arg-729) of the targets by hydrogen bond formation will block the function of the enzyme since these are the prime mediators for dengue viral replication. Thereby, phyto chemicals that inhibit this enzyme may act as good therapeutic agents for the prevention, treatment, and management of dengue fever and can be assessed by this method. For the retrieved bioactive components Tinosporide from*Tinospora cordifolia* (Thunb.) Miers, Santalic acidfrom *Santalum album (Linn.),* Gingerenone-Afrom *Zingiber officinale* (Roscoe), Vasicinonefrom *Sida cordifolia* (Linn.), Beta-santalol from *Cyperus rotundus* (Linn.), Rutin&Geniposidefrom *Hedyotis corymbosa* (Linn.), Thymol from *Plectranthus vettiveriodes* (Jacob)and Ascorbic acid and Gamma-Himachalene from *Chrysopogon zizanioides* (Linn.)r was tested against the target using software the Auto Dock 4. The 2D & 3D structures of the ligands of phytochemicals selected from the ingredients of Seenthil Kudineer have been presented in **Figure.1** and the properties of the ligands have been tabulated in **Table.2.**

RESULTS AND DISCUSSION

The results revealed that the bioactive components in the Seenthil kudineer formulation showed better interaction with the target-PDB 2J7U. The Total Interaction Surface, Inhibition constant, , Electrostatic energy, Binding Free energy and Intermolecular energy of all the compounds have been tabulated in Table.3

Rutin - Binding with target PDB - 2J7U

From the table.3, the Rutin possesses an intense interaction bond with the 729 ARG, 737 ARG and 710 SER. The Rutin's binding score found to be -10.28kcal/mol. Figure 3 displays the hydrogen bond plot and interaction ligand of the compound Rutinin 2D &3D.

Geniposide - Binding with target PDB - 2J7U

From the table.3, the Geniposide possesses an intense interaction bond with the 729 ARG, 737 ARG and 710 SER. The Geniposide's binding score found to be -7.90kcal/mol. Figure 4 displays the hydrogen bond plot and interaction ligand of the compound Geniposidein 2D &3D.

Gingerenone-A-Binding with target PDB - 2J7U

From the table.3, the Gingerenone-A possesses an intense interaction bond with the 729 ARG, 737 ARG and 710 SER. The Gingerenone-A's binding score found to be -7.14kcal/mol. Figure 5 displays the hydrogen bond plot and interaction ligand of the compound Gingerenone- A in 2D &3D.

Santalic acid- - Binding with target PDB - 2J7U

From the table.3, the Santalic acid possesses an intense interaction bond with the 729 ARG, 737 ARG and 710 SER. The Santalic acid's binding score found to be -6.09kcal/mol. Figure 6 displays the hydrogen bond plot and interaction ligand of the compound Santalic acidin 2D &3D.

Gamma- Himachalene- Binding with target PDB - 2J7U

From the table.3, the Gamma- Himachalene possesses an intense interaction bond with the 710 SER and 729 ARG. The Gamma- Himachalene's binding score found to be -5.91kcal/mol. Figure 7 displays the hydrogen bond plot and interaction ligand of the compound Santalic acidin 2D &3D.

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Beta-santalol - Binding with target PDB - 2J7U
From the table.3, the Beta-santalol possesses an intense interaction bond with 729 ARG and 737 ARG. The Beta-santalol's binding score found to be -5.80kcal/mol. Figure 8 displays the hydrogen bond plot and interaction ligand of the compound Beta-santalolin 2D &3D.

Tinosporide - Binding with target PDB - 2J7U
From the table.3, the Tinosporide possesses an intense interaction bond with 729 ARG, 737 ARG and 710 SER. The Tinosporide's binding score found to be -5.43kcal/mol. Figure 9 displays the hydrogen bond plot and interaction ligand of the compound Tinosporidein 2D &3D.

Ascorbic acid - Binding with target PDB - 2J7U
From the table.3, the Ascorbic acid possesses an intense interaction bond with the 710 SER and 729 ARG. The Ascorbic acid's binding score found to be -5.32kcal/mol. Figure 10 displays the hydrogen bond plot and interaction ligand of the compound Ascorbic acidin 2D &3D.

Vasicinone - Binding with target PDB - 2J7U
From the table.3, the Vasicinone possesses an intense interaction bond with the 729 ARG. The Vasicinone's binding score found to be -5.12kcal/mol. Figure 11 displays the hydrogen bond plot and interaction ligand of the compound Vasicinonein 2D &3D.

Thymol - Binding with target PDB - 2J7U
From the table.3, the Thymol possesses an intense interaction bond with the 729 ARG. The Thymol's binding score found to be -4.22kcal/mol. Figure 12 displays the hydrogen bond plot and interaction ligand of the compound Thymolin 2D &3D.

CONCLUSION

Recent therapeutic management available for dengue is only effective in controlling the further severity of symptoms. Hence, in recent times, people have most on integrative treatments for the prevention of dengue. With the help of already published research articles, an array of 10 bioactive components are found in the selected8 herbs in the poly herbal formulation Seenthil kudineer which is indicated for the treatment of Pitha suram (Dengue fever in modern medicine), etc., in the AYUSH system of medicine. Rutin showed a maximum affinity for binding of -10.28kcal/mol, according to the given data in the Table . At -7.90 kcal/mol, Geniposide exhibited the second-highest binding capacity to the amino acids Arg-737, Arg-729, and Ser-710, followed by Gingerenone-A, Santalic acid, Gamma- Himachalene, Beta-santalol, Tinosporide, Ascorbic acid, Vasicinone, Thymol with binding energies in the units of kcal/molof -7.14, -6.09, -5.91, -5.80, -5.43,-5.32, -5.12, and -4.22, respectively (Table 3). Three active sites of amino acids are shared by Rutin, Geniposide, Gingerenone-A, Santalic acid and Tinosporide, whereas two are shared among Gamma- Himachalene, Beta-santalol and Ascorbic acid. Only one active site amino acid is shared by Vasicinone, Thymol(Table 4). This study concluded that the bio-active compounds like Rutin, Geniposide, Gingerenone-A, Santalic acid, Gamma- Himachalene, Beta-santalol, Tinosporide, Ascorbic acid, Vasicinone and Thymol in *Seenthil kudineer*possess significant binding against the amino acid residues . So, the exploratory findings from this study corroborate the bioactive molecules in *Seenthil kudineer,* which have remarkable anti-viral activity for combating the dengue virus.

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CONFLICT OF INTEREST

The authors certify that they do not have any conflicts of interest to disclose.

ETHICS STATEMENT

None

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Table.1. List of herbs present in the Seenthil kudineer formulation with their selected phyto chemicals for the docking study

Sl. No	Herbs	Phytochemicals
1.	*Tinospora cordifolia* (Thunb.) Miers	Tinosporide [8]
2.	*Santalum album* (Linn.)	Santalic acid [9]
3.	*Zingiber officinale* (Roscoe.)	Gingerenone-A [10]
4.	*Sida cordifolia* (Linn.)	Vasicinone [11]
5.	*Cyperus rotundus* (Linn.)	Beta-santalol [12]
6.	*Hedyotis corymbosa* (Linn.)	Rutin, Geniposide [13]
7.	*Plectranthus vettiveriodes* (Jacob)	Thymol [14]
8.	*Chrysopogon zizanioides* (Linn.)	Ascorbic acid, Gamma-Himachalene [15]

Table.2. Selected bioactive components - Ligand Properties

Sl.No	Compound	Molar weight (g/mol)	Molecular Formula	H Bond Donor	H Bond Acceptor	Rotatable bonds
1.	Rutin	610.5	$C_{27}H_{30}O_{16}$	10	16	6
2.	Geniposide	388.4	$C_{17}H_{24}O_{10}$	5	10	6
3.	Gingerenone-A	356.4	$C_{21}H_{24}O_5$	2	5	9
4.	Santalic acid	234.33	$C_{15}H_{22}O_2$	1	2	4
5.	Gamma-Himachalene	204.35	$C_{15}H_{24}$	0	0	0
6.	Beta-santalol	220.35	$C_{15}H_{24}O$	1	1	4
7.	Tinosporide	374.4	$C_{20}H_{22}O_7$	1	7	1
8.	Ascorbic acid	176.12	$C_6H_8O_6$	4	6	2
9.	Vasicinone	202.21	$C_{11}H_{10}N_2O_2$	1	3	0
10.	Thymol	150.221	$C_{10}H_{14}O$	1	1	1

Table.3. Bioactive components against dengue virus protein - PDB 2J7U

Sl. No	Compounds	Binding Free energy (Docking score)kcal/mol	Inhibition constant Ki μM (*uM) (**nM)	Electrostatic energy kcal/mol	Intermolecular energy Kcal/mol	Total Interaction Surface
1.	Rutin	-10.28	29.35**	-0.04	-5.45	770.183
2.	Geniposide	-7.90	1.63*	-0.01	-7.33	685.726
3.	Gingerenone-A	-7.14	5.81*	-0.08	-8.21	767.986
4.	Santalic acid	-6.09	34.08*	-0.64	-7.50	591.192

5.	Gamma- Himachalene	-5.91	46.36*	-0.01	-5.91	535.663
6.	Beta-santalol	-5.80	56.08*	-0.01	-7.18	605.683
7.	Tinosporide	-5.43	105.16*	-0.31	-5.98	627.235
8.	Ascorbic acid	-5.32	126.89*	-0.76	-5.53	419.335
9.	Vasicinone	-5.12	176.56*	-0.04	-5.42	519.812
10.	Thymol	-4.22	804.95*	-0.07	-4.86	454.614

Table.4. Amino acid Residue Interaction of Lead components against the target protein- PDB 2J7U

Compounds	Interactions	Amino acid Residues												
Rutin	3	661 SER	663 ASP	664 ASP	709 CYS	710 SER	711 HIS	729 ARG	734 LEU	737 ARG	761 MET	766 TYR	794 THR	796 SER	798 HIS
Geniposide	3	661 SER	709 CYS	710 SER	711 HIS	729 ARG	737 ARG	794 THR	796 SER	797 ILE	798 HIS			
Gingerenone-A	3	710 SER	711 HIS	729 ARG	737 ARG	761 MET	766 TYR	794 THR	795 TRP	796 SER				
Santalic acid	3	710 SER	729 ARG	734 LEU	737 ARG	758 TYR	761 MET	766 TYR	794 THR	796 SER				
Gamma-Himachalene	2	511 LEU	710 SER	711 HIS	729 ARG	734 LEU	761 MET	766 TYR	794 THR	796 SER	798 HIS	799 ALA		
Beta-santalol	2	729 ARG	734 LEU	737 ARG	761 MET	794 THR								
Tinosporide	3	710 SER	729 ARG	734 LEU	737 ARG	794 THR	795 TRP	796 SER						
Ascorbic acid	2	511 LEU	709 CYS	710 SER	711 HIS	729 ARG	761 MET	766 TYR	794 THR	796 SER	798 HIS			
Vasicinone	1	511 LEU	709 CYS	711 HIS	729 ARG	734 LEU	761 MET	766 TYR	794 THR	796 SER	798 HIS			
Thymol	1	511 LEU	711 HIS	729 ARG	761 MET	766 TYR	794 THR	796 SER	799 ALA	803 TRP				

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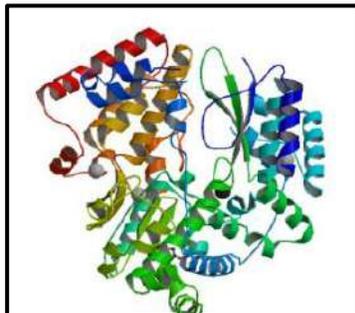
Figure.1. NS5 RNA-dependent RNA polymerase protein in Dengue virus - Structure

Sl.No	Compound name	2D and 3D Structure of selected ligands with active components in each herb in the drug-Seenthil Kudineer
1.	Rutin	
2.	Geniposide	
3.	Gingerenone-A	
4.	Santalic acid	

5.	Gamma- Himachalene	
6.	Beta-santalol	
7.	Tinosporide	
8.	Ascorbic acid	
9.	Vasicinone	
10.	Thymol	

Figure.2. Selected ligands with active components -2D and 3D Structure

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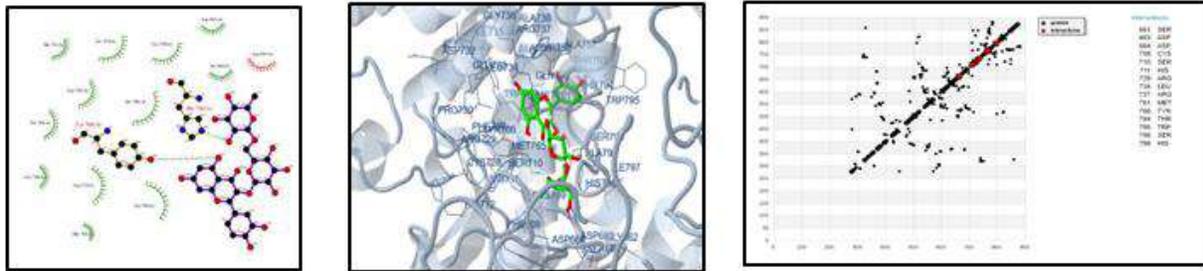
Figure.3. Interactions in 2D and 3D, Hydrogen bond plotting of Rutin with target - PDB - 2J7U
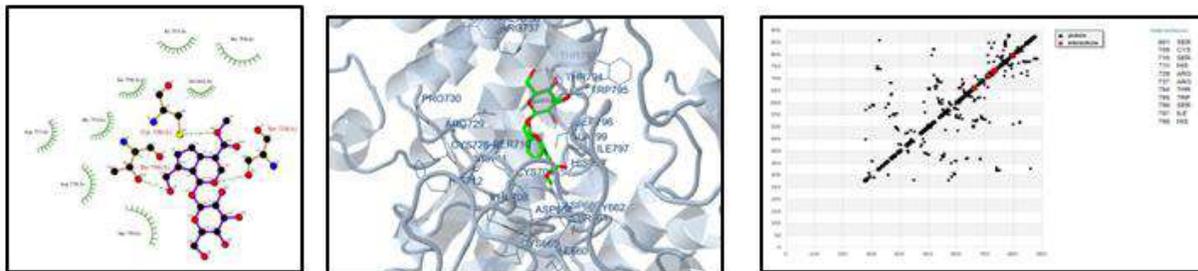
Figure.4. Interactions in 2D and 3D, Hydrogen bond plotting of   Geniposide with target - PDB 2J7U
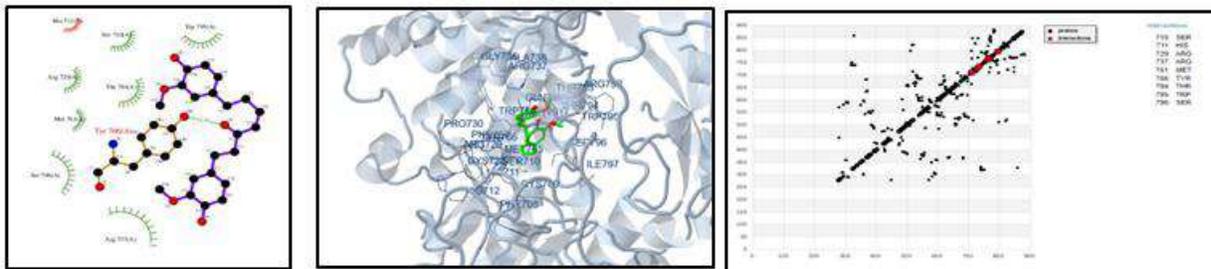
Figure.5. Interactions in 2D and 3D, Hydrogen bond plotting of Gingerenone - A with target - PDB 2J7U
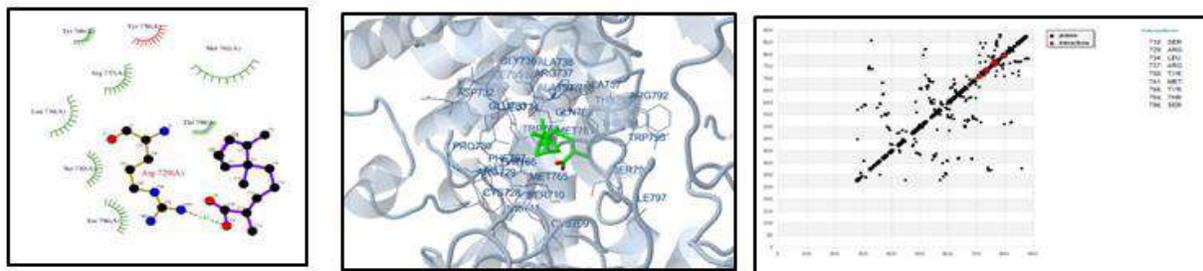
Figure.6. Interactions in 2D and 3D, Hydrogen bond plotting of   Santalic acid with target - PDB 2J7U

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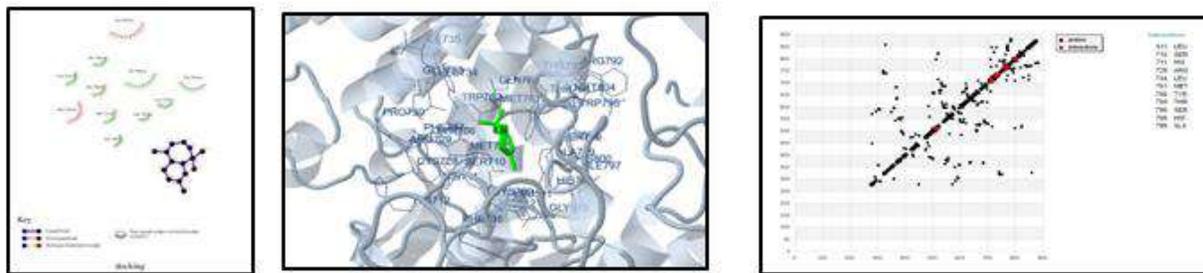
Figure.7. Interactions in 2D and 3D, Hydrogen bond plotting of Gamma- Himachalene with target
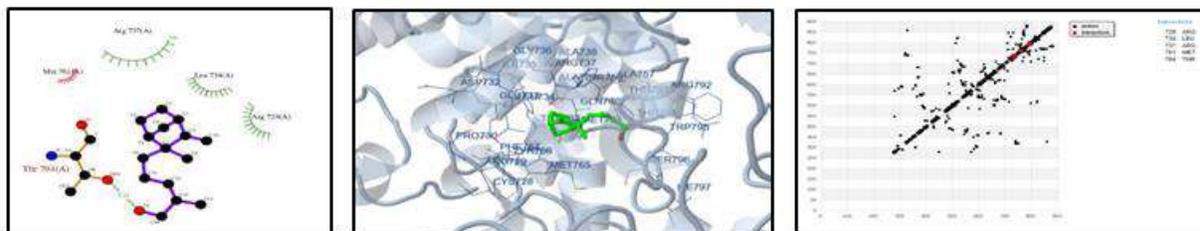
Figure.8. Interactions in 2D and 3D, Hydrogen bond plotting of Beta-santalol with target - PDB-2J7U

RESEARCH ARTICLE

Mikhail Bakhtin's Dialogism in William Shakespeare's King Lear and Macbeth

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ABSTRACT

Mikhail Bakhtin is famous for his dialogism. In his dialogic theory, Bakht in has explained many parts covering language polyphony, heteroglossia, and carnivalesque. Moreover, postmodern research also focuses on *dialogism* in texts written in the past. The research paper endeavorsto delve deep into the tragic theories and pull out the dialogic concept of Bakhtinin Shakespearian plays especially *King Lear and Macbeth.* The term 'Dialogism' comes from dialogue which is an integral part of plays. Bakht in in his theory of dialogism hasside-stepped the use and implication of *dialogism* in drama. In fact,*dialogism* is the grounding element of drama but Bakhtin unfortunately inhabited its significance only in novels. Itis a bid to explain the use of *Dialogism*in various Shakespearian plays. The paper explores the meaning of dialogism and the use of the idea in different tones, either in verbal or written. In dialogic culture, the emphasis is placed on individual traits at play within between cultural groups. Bakhtin opines every dialogue human possesses the capacity to resist, confront and make personal meanings out of change. The paper deduces the fact that dialogic interpretation has extensive scope apart from novels.

Keywords: Dialogism, Polyphony, Heteroglossia, carnivalesque, confront.

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INTRODUCTION

Dialogism is used in many literary works of Mikhail Bakhtin. The particular study focuses on how William Shakespeare's [7] plays are the abundant warehouses of the concept of dialogism. Graham Peachey [6] says, "Mikhail Bakhtin is one of the most influential theorists of philosophy as well as literary studies. His work on dialogue and discourse has changed the way in which we read texts – both literary and cultural – and his practice of philosophy in literary refraction and philological exploration has made him a pioneering figure in the twentieth-century convergence of the two disciplines"(Taylor & Francis). Bakhtin was born in Oryol, Russia in 1895. His works inspired many writers in the field of philosophy, sociology, anthropology, psychology, linguistics, and many other disciplines. He was associated with Russian Formalism, a school of literary criticism that emphasized the functional role of literary devices. Bakhtin's theories were unknown to Western literary scholars. He became famous posthumously. Bakhtin's earlier works stressed ethics and aesthetics. His notion was that a literary work was a crafted idea and the unity of a technical implement. A literary theory that analysis of various levels of communication between works of literature and other authors. In his 1984 study, 'Problems of Dostoevsky's Poetics', Bakhtin states that life expands from one mass to another and one context to another, one social context to another, and from one generation to another. The world is a bridge between myself and another.

 Just as structura lists, Bakhtin's ideas can be said to have sprung from the Russian formalist movement by sharing an interest in the methods of narrative and literary styles (189- 190). But where the formalists' scientific and historical outlook led them to exclusively focus on the technicalities, and the methods of mystification, of texts, Bakhtin, much like the New Historicists, also acknowledged the social and ideological dimension of language (90). Thus, for Bakhtin, Holquist [4] says, "words in literature are not part of the impersonal code of language but as discourse directly dependent on "particular subjects in specific situations"(68). Consequently, literature is a form of communication rather than an independent object, as it, like other types of expressions, depends on the sociohistorical context "at work when the text is produced and when it is consumed"(68-69). The situation that operates the meaning of utterances in literary texts, Bakhtin calls it as heteroglossia; It is a situation in which the subject is "surrounded by the myriad responses he or she might make at any point, but any of which must be framed in a specific discourse selected from the teeming thousands available" (69). Moreover, what can be seen as central to idea of heteroglossia is the notion that the meaning of a word just uttered will be dependent on the circumstantial and unstable conditions of that specific time and place (70). Taghizadeh and Faizi [8] quote in his research, "The fact that it is nearly impossible to decipher all the details that might influence the meaning of dialogues in plays such as Hamlet, for example tone of voice and subtle body language, gives further emphasis to the Bakhtinian notion of literature as essentially finalize – that is, constantly developing, out of reach for any one-sided interpretation (110).

RESEARCH METHODOLOGY

To letter this research paper, the Qualitative Approach of research is followed, wherein the primary sources of selected texts by William Shakespeare like Macbeth, King Lear, and more plays have been analyzed and studied to extract the use of dialogism. To further validate the resources secured by the critical study of various papers written on similar topics.

Dialogism

The word 'Dialogism' extracted from 'dialogue and Bakhtin compared monologue with dialogue. Many poets like Jonh Donne and Robert Browning are the masters of monologue. Browing's 'My last Duchess and Porphyria's Lover are more fascinating works. Bakhtin believe if a person has something in his mind, it is monologue. It was certain that Bakhtin's deep awareness about social, cultural relations and knew language is the only way to express his themes. He puts forward this theory in his "Problems of Dostoevsky's poetics". In dialogism, there is always a room for debate since inquiry is approached ontological emphasizing point of view rather than truth. (67) According to

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Bakhtin, every human possesses the capacity to resist, confront and make personal meanings out of social change. In dialogism, emphasis is placed on individual personalities at play within and between cultural groups (Bakhtin 1985) rather than seeking consequences as a necessary outcome of Dialogism of Bakhtin. Postmodern writers believe poetry is monologic, it has no social connections. In prose, words are dialogical, there is an engagement of different characters, views, voices and world views. Dialogues are generally double-voiced, ironic, parodies or words used in quotations. Double words contain two meanings, one literal and monologic meaning.

Heteroglossia
A dialogue contains conventions, discussions, and views. Bakhtin used the term 'heteroglossia'. which is the use of multiple variations of language and ideas within the language. People use words differently; the same words are used in different circumstances differently. As the speaker is a social person, speaks the same matter, and when he speaks to children, wives, parents, and friends, there is a variation of expression. A village inhabitant expresses his notions using local dialects that might not be the language of a city dweller even though the idea must be similar. Only the way of expression is different. Shakespearian dialects are not commonly used in England. In all his texts, a different kind of diction is casted-off. Heteroglossia is well established in Virginia Woolf's *'Mrs. Dalloway'*, Clarissa Dalloway is the female protagonist and a fictional high-class society lady in the English post-world war. Mrs. Dolla way said she would buy the flowers herself; it seems a very trivial act. But the single line provokes the readers to keep the multiple thought. Readers of various sections of society imbibe it differently.

Polyphony-it is related to music composition in which more than one melodious lineis sung simultaneously in a harmonic way refers to the polarity of independent unmeshed voices or consciousness, different word views but interact with each other they don't change their worldview, they remain independent. We as readers, while reading feel that it is not written by a single author but rather too many characters. Bakhtin says Tolstoy's works are monologic. All characters have their dialogue but they merge in the authors' view it becomes monologic. Dostoevsky's characters are not objective but plural. If the voices of the characters are merged the voices of the author, it does not become dialogic but the polyphonic

Carnivalesque This term is developed from the carnival. In the medieval period, during the time of Christmas, common people used to drink, enjoy and have merriment, sex, sing and dance and have fun free, a kind of democratic culture, social hierarchy was free, people of different culture engaged in different activities irrespective of their social status. People of opposite nature tried to interact with each other. The word 'carnival' in literature refers to the movement in literature or literature as whole when such types of situations are oriented. Shakespeare is "Carnivalesque" than polyphonic. One may, however, think otherwise, and Knowles (1998:11) and also believes that "The oddest thing of all is that is the opposite seems self-evident". "Here hung lips that I have kissed I know not how oft"-HamletAct5(seen1 -175), the grave digger sees one skull (grave digger's scene), the gravedigger is indifferent to that but Hamlet identifies that the skull is the skull of York He found it meaningless whether it was the skull of Julius Caesar, Alexander, or a beggar, all are meaningless.

The social hierarchy has no meaning. Death is the great equalizer; Prince Hamlet realizes it. This moment can be termed as carnivalesque in drama. Bakhtin argues that carnivalization reached its highest peak in Farva Revile and Theodore Dostoevsky. His characters line in a border of its opposites, they have opposite world views and contrast in their views but they interact with each other, they compete with each other and some of his characters are low and some are high, and some are lofty and some are destructive, but they compete with each other, they do not change their world views but they try to understand each other and came to a consensus. Dostoevsky does not come to a finalization of his character's consensus because he realizes it has to be put for the future. He possessed a negative capability. Bakhtin traduces the term 'Heteroglossia' to mention the plurality of independent, autonomous, merged voices in literary texts, be it novel, drama or any other narrative texts. Dialogic criticism refers to as type of criticism which is based on the unique concepts introduced by Bakhtin in his literary studies.

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William Shakespeare

Ben Johnson [5] calls Shakespeare, "not of an age but for all time". Shakespeare, the dramatist of all time, seasons that world has ever produced. He is mostly quoted immediately after the Bible. His works have been produced in almost all the languages. Shakespearian plays are modified in many languages. His characters have social realities rather than theatrical realities, characters like Julius Caesar, Hamlet, King Lear, Othello, Macbeth, Shlock and many. At the early stages of his career, Shakespeare himself was an actor, and be loyal to the Queen Elezabeth and wanted get the patronage from the queen. In his life time, Shakespeare, had seen the age of Elizabeth and Jacobean. In 1585, he started his career and opened a drama company named 'Lord Chamberline's man' and this company was known as Kings Man. Up to 1613, he extended his writings and at the age of 49, he took retirement from writing.The years in between 1585 and 1592 have been called "the lost years" as there was no record of his life was not known to the world. At the outset, Shakespeare wrote comedies and then historical plays and tragedies. At the last stage of his writings, Shakespeare wrote romantic plays. Shakespeare never wrote anything for become famous but for money. There were two actor friends, John Hemmings and Henry Condell in his drama company, and they published his first folio in 1623. And the preface of these first two folios were written by Ben Johnson. In 1603, queen Elizebeth died and King JamesI came in to the throne and he gave the Royal Patent to Shakespeare's company and the name became King's Man. In 1599, Shakespeare opened a theatre named Globe Theatre in partnership. This theatre was opened for all classes, neglecting the social status. He wanted his plays should be attracted to all classes. By then, Shakespeare became rich and bought lot of properties in London and his birthplace Stort ford. In1610, Shakespeare retired form his public life as an early age. It was the time of plague in London it might be the reason for the early retirement form the public life, not from writing. But he wrote in collaboration with John Fletcher. In 1613 he completed his writings, and he spent his remaining life in his native village Stratford-up on Avon and in April,1616, he took his last breath and buried in his nearby country churchyard. It was written on his tomb, "Good friend for Jesus' sake forebear. To dig the dust enclosed here. Blessed be the man that spares these stones. And cursed be he that moves my stones". Shakespeare always wrote on fashion prevailed in the market. His best works were written in Jacobean Age nevertheless he was known as an Elizabethan playwright.

Shakespearean Plays

Shakespearian plays are unmatchable, which are classified as comedies, historical plays, tragedies and tragicomedies. There are 37 plays altogether. Shakespearian plays were written mainly in Elizabethan and Jacobean Age. His well-known tragedies are Hamlet, Julius Caser, king Lear, Macbeth, Antony and Cleopatra, Coriolanus, Othello and many. Shakespearean comedies are sub divided into tragicomedies, romances and problem plays, which are the dramas have elements of tragedies, humour and complex plots, an important play in this category is "All well that end well" and was written in between (1601-1605).And "As You Like It" is one of the most important comic plays (1598-1600). Another important problem play is "Measure for Measure" (1603-1604) Merchant of Venice(1596-1597), and Mid-Summer Night's Dream(1595-1596) "The Tempest" is the tragi- comedy or late romances, written in the year1611.Historical pays or chronical plays are Henry IV(I), Henry IV(II), and also HenryV, and Henry VI(III), king John and so on they all belong to the real king of England. Shakespearean tragic characters are generally isolated ones. They are socially broken down like Hamlet and King Lear. Occurrences are inseparable and indispensable. The central characters are generally nobles but due to the flaw of the characters lead them to the drastic end. Most of the historical characters are English monarchs, they glorify and propagate king or queen's vitality and courage. Many historians opine that Shakespearian characters are real like beings, and powerful presentation of images but Dr, Johnson's view is something different "[S]spectators are always in their senses, and know, from the first act to the last, that the stage is only a stage, and that the players are only players." Shakespeare extracted plots for his plays from the known areas with good reasons. It was for the situations, To establish Scottish history he plotted 'Macbeth' and published in the 'First Folio' by his friends.

Dialogism in King Lear

Dialogism is the term used specially by Mikhail Bakhtin, the Russian formalist. Bakhtin used this term in his works "Problems of Dostoevsky's Poetics" and "Rabelais and His World", but do not have the connections with plays. Bakhtin never talked about dialogism in plays. Writer speaks through characters. When they speak, there is a

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diversification of meaning. It is not only the character, but the author's view is there, and justification of the reader, and the look out of the audience, all are different. The study attempts to establish major implications of *dialogism* in King *Lear*. Michael Gardiner [3] distinguishes dialogism and monologismin two respects. Monologic world is always gravities itself only and is a referential object. But the dialogic aspect is locked into an intense relationship with the world the of others. It is having an address towards someone- a listener, an arbitrator or simply anyone. There is always a chance of response. Dialogue is a passive vehicle of neutrality of information or description. It is designed to provoke a response and it gives the chance of initiating another dialogue or to initiate a dialogue, it is a coliseum for the battle between different voices and is charged with hostile, burlesque, appraisal and many more. What Bakhtin means is that dialogue utterances isas 'double – voiced', 'vari -directional, and 'multi accented'. (28-29). Shakespearean plays have instances of dialogism. Many of his plays can be studied in light of the theory of Dialogism. King Lear addressing the elements in another part of the Heath and The Fool listens the talk. King Lear is caught in the trouble of dangerous storm, thunder and lightning. He is left with two of his daughters Goneril and Regan, and the youngest daughter Cordelia is married to the King of France and he became alone and curses himself about his for his wrong decision to leave Cordelia with bare hands. He was fallen into the craft of the other daughters and vexed to take the right decision.

Lear:"Blow, winds, and crack your cheeks! rage! blow!
You cataracts and hurricane, spout
Till you have drench'd our steeples, drown'd the cocks
You sulphurous and thought-executing fires,
Vaunt- couriers of oak-cleaving thunderbolts,
Singe my white head! And thou,all-shaking thunder,
Strike flat the thick rotundity o'th' world!
Crack Nature's moulds, all German spill at once
That makes ingrateful man!" (Ac. III sc. II 1-10)

King Lear's incoherent mad words show the pride of a King though he lost his wit.A king can never lose his natural rights. No natural power can defeat and challenge him. When the king transfers his power and authority to the daughters, marks the beginning of the downfall his personality.

Lear:"Nature's above art in that respect. There's you
Press- money. That fellow handles his bow like a
Crow- keeper: draw me a cloth's yard. Look, look!
A mouse, Peace, peace! This piece of toasted cheese
Will don't. There's my gauntlet; I'll prove it on a giant.
(Ac. IV sc. VI 86-91)

King Lear's character has a marked development. It is treated as the greatest portrayal of the dual character of a hero in the same play. In the beginning, Lear strikes as haughty, cocky, egoistic, self-centred, conceited, and smug, buttowards the end, became benign, compassionate, merciful, and reticent. Humility is the striking characteristic of Lear in Acts IV and V. Misfortune can be the ultimate reason for this behavioural change. It is the redemption of Lear's character when he happens to see his youngest daughter as a prisoner with him.

Lear. No, no, no, no! Come, let's away to prison:
We two alone will sing like bird i'th' cage:
When thou dost ask me blessing, I'll kneel down,
And ask of thee forgiveness: so we'll live,
And pry and sing, tell old tales, and laugh
At glided butterflies, and hear poor rogues
Talk of court news; and we'll talk with them too,

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Dialogism in Macbeth

Bost ad [2] said that Drama is more dialogic than any other forms of literature if spite of the unjust view of Bakhtin towards drama. In drama, author's view, more confrontation of characters and readers view is established well. There is 'polyphony 'of language and manipulation of ideas arise as the 'dialogic' establishment is more prevalent in drama. Human relations are equipped with conflicts and charges. But not aimed for others. In such interactions, sounds are signs [which are] in this seen as an open meaning resource; their actual meaning can emerge in situated, specific social interaction (7), Like any of other Shakespearian plays, 'Macbeth' is a warehouse of Bakhtinian concept of dialogism. Bakhtin supports his peer A.V. Lunacharsky that "Shakespeare is polyphonic to the extreme"(32) He writes: "Lunacharsky is correct in the sense that certain elements, embryonic rudiments, early buddings of polyphony can indeed be detected in the dramas of Shakespeare" (33). However, this statement is immediately undermined when he thinks that "but to speak of a fully formed and deliberate polyphonic quality in Shakespeare's drama is in our opinion simply is impossible"(33) Mikhail Bakhtin's [1] dialogism is well established in William Shakespear's 'Macbeth'. Shakespearean plays dramatize human relations, conflict-ridden contexts and provide space for dialogue as prescribed by Bakhtin. In 'Macbeth', William Shakespeare picturised the protagonist Macbeth and his progression is being like a valiant undefeatable warrior, and then in due course a conspirator and then to a cold-blooded murderer. But he some time becomes a philosopher in the way of his intellectual dialogues. The greed for power and witch craft leads his wit to a treacherous dictator and plot the murder of his own King by plotting with some hired murders. It became a need for him due to not only his inner turmoil but also his excessive greed for power belief in witches' phony. Depth of psychology is traced in the 'scene of dagger and porter'. The scene depicts the destructive nature and the travel of Macbeth towards the self-entity and psychological blood shed of King Duncan. Lady Macbeth quotes, "Infirm of purpose! Give the daggers" (255). The fulfilment of the prophecy turns Macbeth into covetous and gluttonous and the thought of murdering his own pious king. When the noble, Ross calls him 'thane of Cawdor', Macbeth's mind yearned for the power of throne but he is sceptic of the prophecy.

Macbeth. Stay, you imperfect speakers, tell me more
By Sinel's death I know I am Thane of Glaimis;
But how of Cawdor? The Thane of Cawdor lives,
A prosperous gentle man; and to be king
Standsnot within the prospect of belief,
No more than to be Cawdor, Say from whence
You owe this strange intelligence? or why
Up on this blasted health you stop our way
With such prophetic greeting? Speak. I charge you.
(Ac. I sc. III70-78)

Another instance of dialogic eloquence is seen Act IIIof Macbeth. The wicked state of utterance, despite of the murderer- self of Macbeth expresses the quality of a warrior. The mental state of Macbeth becomes irrational, and Lady Macbeth tries to sooth him.

Macbeth. We have scotch' the snake, not kill'd it:
Sh'll close and be herself, whilst our poor malice
Remains in danger of her former tooth.
But the frame of things disjoints, both the worlds suffer,
Ere we will eat our meal in fear, and sleep
In the affliction of these terrible dreams
That shake us nighty. Better be with the dead,
Whom we, to gain our peace, have sent to peace,
Than on the torture of the mind to lie
In restless ecstasy. Duncan is in his grave;
After life's fitful fever he sleeps well;

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Treason has done his worst: nor steel, poison,
Malice domestic, foreign levy, nothing
Can touch him further:
(Ac. III sc.II 14-27)

In its richness of importance and complexity of dialogism, Macbeth becomes philosophical when he hears about the death of his wife Lady Macbeth, and thinks about the trifling nature of life. The analogy of life and his greed for power still makes him more philosophical. Ambition, violence, fate, natural and unnatural incidents, and the reflection of manhood.

Macbeth. She should have died hereafter.
There would have been a time for such a word.
Tomorrow, and to-morrow, and to-morrow,
Creeps in this pretty pace from day to day,
To the last syllable of recorded time;
And all our yesterdays have lighted fools
The way to dusty death. Out, out, brief candle!
Lif's is but a walking shadow, a poor player
That struts and frets his hour upon the stage,
And then is heard no more; it is a tale
Told by an idiot, full of sound and fury,
Signifying nothing.
(Ac.V Sc. V 16-28)

FINDINGS

In the research, it is found that William Shakespeare used dialogism, carnivalesque, heteroglossia, and polyphony in almost all the plays. Mikhail Bakhtin emphasized these terms in his novels only and never tried to use these terms in plays. Shakespeare had experimented with all these terms many years before. The characters like Hamlet, Macbeth, King Lear, and Julies Caesar and their dialogues are real-like figures. The speeches of these characters are addressed to someone. Shakespearian characters have a perpetual existence away from the writer.

CONCLUSION

The study focuses on Michail Bakhtin's dialogism in William Shakespeare's two plays, "King Lear and Macbeth." Bakhtin emphasized the theory of dialogism in novels. Dialogue is a fundamental part of drama, but Bakhtin side-lined the necessity of dialogues in plays. Bakhtin's *dialogism* is an extract from dialogue, which is the core of all plays especially in Shakespearean plays. Shakespearean characters live through their dialogues. Shakespeare as a writer is the embodiment of human freedom. This paper fully focuses on the multiple theories of Mikhail Bakhtin's 'Dialogic theory and its various dimensions and an attempt at the Bakhtini an theory of dialogism in Shakespearian plays especially *King Lear and Macbeth.* The dialogues used in Shakespearean plays are addressed to someone. The language of *King Lear and Macbeth* are *dialogic* in multiple scenes and are both the fulfillment of desired intentions and communication. *Polyphony* of language emerges due to conflict and tension. Language is never a simple means of extracting the world of abstract ideas into extensive forms. It is deeply charged with significance; it stays even beyond the scope and control of the speaker. The interpretations of language are multi-dimensional.

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RESEARCH ARTICLE

A Bibliometric Study on Parent Brands and Brand Extensions: Recent Trends and Future Agendas

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ABSTRACT

The study explores the landscape of parent brand and brand extension literature, employing bibliometric analysis, performance analysis, science mapping, and network analysis to unveil trends and future research directions. Analyzing 195 articles from Scopus, the research reveals a burgeoning trend in collaborative research, with the United States, China, and Spain leading in both individual and collaborative contributions. Key journals include the "*Journal of Product and Brand Management," "Journal of Brand Management,"* and "*Journal of Business Research.*" The study identified 'brand extension' as the most frequently used keyword in the domain. The study also identifies annual publication trends, most prolific subject areas, top authors, institutions, themes, references, publications, sources, and emerging trends in the domain. Additionally, the study examines the collaboration patterns among countries and the collaboration output of different nations. The study also creates a three-field plot and references spectrography of documents for an in-depth analysis of the domain. Practical implications span academia, businesses, and marketers, providing insights into research gaps and areas requiring further investigation. The study's uniqueness lies in its comprehensive methodology, utilizing advanced tools like Biblioshiny, VOSviewer, and MS Excel to offer an in-depth understanding of the domain.
Keywords- Literature Review, Bibliometric Analysis, Parent Brand, Brand Extension, Network Visualization, Core Brand.

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INTRODUCTION

The changing market dynamics have a significant influence on business decisions. To stay ahead of the competition in this tumultuous, intricate, and competitive economic environment, organizations must implement a variety of marketing methods. One of the key methods most corporations use is the frequent development of new products and their launching to keep up with the competition. There is a significant risk involved for many businesses when they introduce new goods or services or enter new markets (Bousch & Loken, 1991). It is very risky for corporations to bet on new brands or products that are entirely new to the market. In such a situation, corporations leverage their old brands that are already established in the market. The use of an existing brand name while permitting an established brand to enter a completely new product class is referred to as a 'brand extension strategy' (Aaker & Keller, 1990; Tauber, 1981). It should come as no surprise that companies selling consumer products are lining up to capitalize on the value of well-known brands through expanded launches. This is most preferred by corporations to leverage already established, profitable, trusted, and lovable brands rather than to launch an entirely new brand. This preference is mostly due to the parent brand's advantages in terms of brand equity, providing protection against a hazardous and likely failed brand launch. There is a widespread idea that brand extension techniques strengthen and convey strong brand positioning, raise awareness and quality associations, and boost the likelihood of trial by lowering customer risk for new products. Brand extensions, or the use of well-known brand names for new product debuts, are such highly common branding strategies among corporations that almost 80% of new product debuts in some product categories are brand extensions (Keller, 2003). So, it can be concluded evidently that the brand extension strategy is a very pertinent and crucial strategy for corporations in this era, but its success, failure, and acceptance depend on the brand that owns these extensions. The present study will look into the domain of extended brands as well as the parent brand's literature published in the Scopus database. Various strategies, as well as techniques, are used in the following analysis. A description of all these elements as well as their results and findings will be presented in upcoming sections using graphs, tables, and diagrams.

BACKGROUND OF THE STUDY

The study of brand extensions has been a topic of interest among academics and researchers for several decades. The foundation for this research area was established in the 1960s and 1980s, with a focus on semantic generalization and the transfer of perceived similarity between parent brands and extended brands (Boush et al., 1987). The categorization approach developed by cognitive psychology, specifically the work of Rosch & Mervis (1975), provided the basis for advancements in understanding brand extensions (Boush et al., 1987). Building on the groundwork laid by previous studies, Aaker and Keller (1990) made significant contributions by examining the three essential elements of perceived similarity: complementarity, substitutability, and transferability, as well as the overall quality of the original brand and the perceived difficulty of the extension. These findings served as the basis for subsequent studies and further contributed to the field (Aaker & Keller, 1990). Researchers explored various methodologies, such as the theory-based approach, which incorporated contextual influences in the evaluation process (Barsalou, 1982; Cohen & Basu, 1987; Murphy & Medin, 1985; Sujan, 1985).The study of brand extensions gained momentum in the 1990s. Loken and Roedder John (1993) provided empirical evidence on the detrimental effects of brand extensions on the core brand image, focusing on specific attributes rather than the brand image as a whole. Further investigations into brand extension typology and evaluation methods were conducted by Boush and Loken (1991), who examined the breadth of psychological processes and the range of a brand's existing offerings (Boush & Loken, 1991). Their research highlighted the two-stage evaluation process utilized by consumers when assessing reasonably common extensions, involving classification attempts followed by piecemeal processing (Boush & Loken, 1991).

RESEARCH OBJECTIVES

This research study aims to guide future research in core brand and brand extensions by uncovering trends and research gaps. The objectives of this study include analyzing annual publication patterns, subject area contributions, leading journals, prolific authors, and prominent sources. It also explores global scientific collaboration, highly cited

publications, frequently cited references, keywords, and the most used research themes in the domain. The study further analyses the literature using a three-field plot and referencespectrography for a more comprehensive analysis. Utilizing Biblioshiny, VOSviewer, and MS-Excel, the study conducted performance analysis, science mapping, and network analysis. These objectives collectively offer a nuanced understanding of the domain, providing a valuable roadmap for researchers in this field.

RESEARCH METHODOLOGY AND TECHNIQUES

This study utilizes a comprehensive bibliometric analysis methodology to examine the literature on "Parent brand" and "Brand extensions" using mathematical and statistical techniques within the field of bibliometrics (Rodriguez et al., 2020). The analysis incorporates performance analysis and scientific mapping for better bibliometric analysis, following the recommendations of Cobo et al. (2011). Performance analysis aims to measure the output and impact of scientific publications, providing insights into the productivity and influence of authors, universities, and countries. Scientific mapping analysis helps identify structural and dynamic patterns in research. Moreover, the "PRISMA flowchart also used in the presented study, PRISMA" likely refers to the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) framework. PRISMA is a widely accepted set of guidelines used in academic research for conducting systematic reviews and meta-analyses."Computer tools such as VOSviewer and Biblioshiny are utilized to construct bibliometric networks for journals, authors, specific papers, bibliographic coupling, co-citation, or co-authorship analysis.

Search Strategy and Search String

The bibliographic information for this research was collected using the Scopus database, which was chosen due to its vast collection of publications. Scopus is widely recognized as the largest database of journals, surpassing other databases like "Web of Science" in terms of the number of publications it includes. This vast coverage makes Scopus an ideal choice for conducting this bibliometric analysis. PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) flowcharts provide a standardized graphical representation of the systematic review process. Covidence, a tool designed to streamline and manage systematic review workflows, including the creation of PRISMA flowcharts, was utilized for screening purposes in this study. Figure 1 illustrates the various search strings used to ensure comprehensive coverage of articles related to core brand, parent brand, brand extensions, extended brands, and brand stretching. Keywords such as core brand, parent brand, brand extensions, extended brands, and brand stretching were included in the search query: '(TITLE-ABS-KEY("CORE BRAND") OR TITLE-ABS-KEY("PARENT BRAND") AND TITLE-ABS-KEY("BRAND EXTENSION") OR TITLE-ABS-KEY("EXTENDED BRANDS") OR TITLE-ABS-KEY("BRAND STRETCHING"))'. The Scopus database's title-abstract-keywords column was searched using these keywords. The search was further narrowed down to English articles published between 2004 and 2023: '(LIMIT-TO(LANGUAGE, "English") AND PUBYEAR > 2003 AND PUBYEAR < 2024)'. Only journals and sources related to business, management, accounting, social sciences, psychology, arts, and humanities were included in the analysis: '(LIMIT-TO(SUBJAREA, "BUSI") OR LIMIT-TO(SUBJAREA, "SOCI") OR LIMIT-TO(SUBJAREA, "PSYC") OR LIMIT-TO(SUBJAREA, "ARTS"))'. Initially, 269 articles were extracted from Scopus, with the subsequent exclusion of 74 studies due to their irrelevancy,after screening titles, abstracts, and full-length articles, and the elimination of one article due to itsduplicity. Covidence software facilitated this screening process. Following these steps, the analysis focused on 195 articles, and the results are detailed in the subsequent sections of the study.

DATA ANALYSIS AND RESULTS

The analysis is focused solely on 195 articles that appeared in 92 different sources. Table 1 provides all pertinent information about the publications, such as the average age of papers (9.38 years), the average number of citations per document (27.64), and the annual growth rate (-1.5). There were a total of 23 single-authored documents and the remainder were co-authored. 401 authors worked on these articles, and 507 authors' keywords were used. Based on 8647 references, these articles were compiled.

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Figure 2 displays the annual trend of papers published between 2004 and 2023. After reaching a peak in 2010, the number of publications in the domain decreased. From 2006 to 2010, the number of research articles in the field increased significantly. The number of scientific papers was at its lowest in 2023 since 2003, but it can't be denied that the data for 2023 is only up to April 20, 2023. The graph above illustrates all variations in the number of publications for the selected years. The proportion of publications across various subjects is illustrated in Figure 3. The primary influence on the topic at hand was "Business Management and Accounting," constituting 61.9% of all research articles. This was followed by subject areas in "Economics, Econometrics, and Finance," "Social Sciences," and "Psychology. The analysis of all top sources is presented in this section. The results of the analysis revealed that the *'Journal of Product and Brand Management'* is at the top with 17 documents in the domain, 432 total citations, an 11 h-index, a 17 g-index, and an average citation of 25.4 per publication. Following this, the *"Journal of Brand Management"* ranks second with a total of 9 documents in the domain, a 7 h-index, a 9 g-index, a .467 m-index, 140 total citations, and an average citation of 15.6 per publication. The third rank is held by the *'Journal of Business Research'* with an 8 h-index, a 9 g-index, a .5 m-index, 9 publications in the domain, and an average citation of 19.2 per publication. The fourth rank is occupied by the '*InternationalJournal of Research in Marketing'* with 7 documents, a 6 h-index, a 7 g-index, a .333 m-index, 334 total citations, and an average citation of 47.7 per document.

The contribution of a country can be evaluated using the number of publications published in the domain area. The collaboration network depicted in Figure 6 indicates that the United States has the highest number of articles (34) in which it has the most independent articles (25) and the rest 9 are multiple collaboration publications, accounting for the highest percentage of total publications. China came in second with a total of 18 publications in total from which,12 papers are single-authored, and 6 are multiple authors collaborations, Spain is ranked next with 6 and 6 single and multiple collaboration publications. Germany followed the rank next with 10 publications in total and 5 and 5 publications as SCP and MCP respectively. India followed ranked with 10 papers and all publications made are single-authored only. There is no multiple collaboration publication by India in the domain. The international research partnership is represented by the map's blue tint and a description of that is given in above table 4. The degree of author collaboration may be seen in the pink ring that links the various nations. It is intriguing to see how the nations with the greatest number of publications on the topic area worked together in this manner. The frequency of collaboration between the United Kingdom and Spain is the greatest at 5. The United States collaborated with China, Chile, Canada, and the Netherlands for 4 publications each.

The analysis of leading authors has been conducted, and the results revealed that "Sattler H" is the most productive author in the domain. The author has 6 documents in the domain, a 6 h-index, a 6 g-index, a .333 m-index, 785 total citations, and an average citation of 130.83 per publication. The second rank is occupied by "Boisvert J" with 5 documents, a 4 h-index, a 5 g-index, a .267 mindex, 81 total citations, and an average citation of 16.2 per publication. Following this, the third rank is held by "Dwivedi A" with 5 documents in the domain, a 5 h-index, a 5 g-index, a .357 mindex, 94 citations in total, and an average citation of 18.8 per publication. The analysis is further followed by "Merillees B" with 5 documents, a 5 h-index, a 5 g-index, a .357 m-index, 94 total citations, and an average citation of 18.8 per publication.

In this section of the research, several academic institutions from across the globe are evaluated for their studies on parent brands and brand extensions. The top institutions in the subject field from 2004 to 2023 with the most research articles published are shown in the aforementioned table. The study's findings showed that while all of the top institutions produced the same amount of articles in the field there is a great disparity in citations. "The University of Southern California, in the United States", came out on top when it came to citations with 2 papers and 276 authors citing it and the institution has 138 average citations per publication. The second position is held by the "Cass Business School, City University, London, United Kingdom" with 2 documents with 148 citations and 74 average citations per publication. "NHH, Norwegian School of Economics and Business Administration, Bergen, Norway" is at 3rd rank with 2 documents, 93 citations, and 46.5 average citations per publication.

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Due to the tremendous growth of papers in this field over the past 20 years, studies related to brand extensions and parent brands have made significant advancements. This section evaluates the most cited documents in the subject area. The caliber, authority, and significance of a research paper published are determined by the volume of citations it receives. The analysis table consists of the top 3 documents, and the analysis revealed that "Drivers of Brand Extension Success (2006)" by Völckner and Sattler receives the highest number of citations, with 394 citations, and is published in the "*Journal of Marketing*." This study investigates the success factors of an extended brand under a parent brand. Other publications, along with their publication years and the number of citations they obtained, are depicted in the table above.

The graph above depicts the co-citation of the most cited references using VOSviewer for the analysis. Two papers are considered to be co-cited if at least one other document references them both. The selection criteria were at least 10 citations to the cited reference and out of 8575 cited references only 68 meet the threshold. The study revealed that "Aaker D.A., Keller K.L., Consumer Evaluations of Brand Extensions, *Journal of Marketing*, 54, 1, pp. 2741, (1990)" is the most cited reference with a citation of 95, followed by "Keller K.L., Aaker   D.A., The Effects of Sequential Introduction of Brand Extensions, *Journal of Marketing Research*, 29, 1, pp. 35-50, (1992)" with 34 citations, and "Broniarczyk S.M., Alba J.W., The Importance of the Brand In Brand Extension, *Journal of Marketing Research*, 31, 2, pp. 214- 228, (1994)" is at the 3rd rank with 32 citations while "Czellar S., Consumer Attitude Toward Brand Extensions: An Integrative Model and Research Propositions, *International Journal of Research in Marketing*, 20, 1, pp. 97-115, (2003)" follows the ranking.

The main components of the three fields plot (e.g. authors, keywords, journals) and their relationships are illustrated in the above diagram using a Sankey diagram with arrow widths and flow rates. The height of the rectangle represents the sum of the relationships that have occurred between the object represented by the rectangle and other elements of the diagram. The size of the rectangle determines the number of relationships for each object. The present study revealed the research topics explored by the researchers and the factors on which the researchers relied heavily. The results revealed that "Brand Extensions" is the most important node with a 13 flow count while the 2nd highest related node is "Brand Extension" with an 11 flow count followed by "Brand Equity" with a 10 flow count and "Brand Image" with a flow count of 10. "Dwivedi A." is the most productive author in the domain while "Merrilees B." is the 2nd highest in the productivity and consumer evaluation of brand extension by "Aakar D.A" is the most cited publication in the domain. While "Journal of Marketing" and the "Journal of Marketing Research" are among the top journals.

Each reference referenced in a scientific paper is shown on a histogram in RPYS and then has its publication year smoothed down using a mathematical formula. The resultant curve shows how the article was referenced, with the tallest peaks denoting the sources that were cited the most frequently and the curve's shape denoting the sources' age distribution. And the data showed that the greatest amounts of research were conducted in 2000. There was no particular research conducted in the field of brand extensions between 1838 and 1950. However, studies continued after that, grew slightly, and created an impact. In 2000, these studies had the greatest impact, and it was the year in the domain where most publications cited them. After that, there was a continuous decline year after year, and the number of citations and the total number of citations both declined steadily.

The keyword analysis table reveals the prominence of certain terms in the domain of brand extension. "Brand Extension" and "Brand Extensions" hold the top positions with frequencies of 64 and 58, respectively, indicating their central role in the literature. "Brand Equity" follows, appearing 17 times, emphasizing the significance of assessing brand value. Additionally, terms like "Brand Image" and "Brand Management" both occur 15 times, underscoring the attention given to the perception and strategic handling of brands. Other relevant keywords include "Consumer Behaviour," "Perceived Fit," "Brand Loyalty," and "Advertising," shedding light on diverse aspects within this research field. The words that are not used frequently are the research gaps for future research studies.

Cluster 1,"Brand Strategy and Extension Factors," delves into the forces that impact a brand's expansion and influence, encompassing concepts such as advertising, brand extension, and perceived fit. This cluster scrutinizes strategic planning and determinants of brand growth.

Cluster 2, "**Strategic Brand Ecosystem: Leveraging Identity, Innovation, and Spillover Effects**," centers on the interplay between brand identity, innovation, and the holistic brand environment. It explores how these elements collaboratively shape a brand's strategic positioning and its cross-effects.

Cluster 3, "**Brand Metrics Insights**," concentrates on quantifiable measures that facilitate an in-depth comprehension and assessment of brand performance. Key indicators such as brand attitude, equity, loyalty, and perceived quality are investigated here.

Cluster 4, "**Exploring the Interplay of Brand Personality, Brands, and Consumer Behavior**," delves into the complex dynamics between brand personality, consumer perception, and resultant behaviors. This cluster investigates how a brand's personality influences consumer interactions.

Cluster 5, "**Brand Image and Service**," examines the dimensions of brand image and service quality, highlighting their interconnectedness. This exploration sheds light on how a brand's image is reflected through its services.

Cluster 6, "**Feedback Effects of Brand Extension**," revolves around the repercussions of extending a brand's offerings. It scrutinizes how such extensions can impact the original brand and its existing products or services.

In summary, these clusters collectively provide a comprehensive understanding of different facets of brand management, encompassing strategic growth, identity, metrics, consumer behavior, service quality, and the dynamics of brand extensions.

DISCUSSION

The data analysis and results of this study provide valuable insights into the evolving landscape of parent brands and brand extensions. Examining 195 articles from 92 sources spanning from 2004 to 2023, the study reveals a fluctuating annual publication trend, with a notable peak in 2010 followed by a subsequent decline, signaling dynamic shifts in research focus over time. The dominant influence on the subject matter was "Business Management and Accounting," comprising 61.9% of all research articles. Subsequent significant contributions came from subject areas such as "Economics, Econometrics, and Finance," "Social Sciences," and "Psychology." Leading sources such as the *"Journal of Product and Brand Management,"* and *"Journal of Brand Management,"* emerge as influential contributors to the field, underscored by key metrics like h-index, g-index, and total citations. RPYS of the data showed that the greatest amounts of research were conducted in 2000. There was no particular research conducted in the field of brand extensions between 1838 and 1950. The study revealed that "Aaker D.A., Keller K.L., Consumer Evaluations of Brand Extensions, *Journal of Marketing*, 54, 1, pp. 2741, (1990)" is the most cited reference with a citation of 95, followed by "Keller K.L., Aaker D.A., The Effects of Sequential Introduction of Brand Extensions, *Journal of Marketing Research*, 29, 1, pp. 35-50, (1992)" with 34 citations. The frequency of collaboration between the United Kingdom and Spain is the greatest. The United States collaborated with China, Chile, Canada, and the Netherlands for 4 publications each. The exploration of international collaboration highlights the United States as a major player, fostering global partnerships with China, Chile, Canada, and the Netherlands. In authorship and institutional contributions, "Sattler H" stands out as the most prominent author, while institutions like the University of Southern California and Cass Business School demonstrate significant productivity and citations. The study identifies impactful publications, with "Drivers of Brand Extensions Success" leading in citations. Keyword analysis emphasizes the central themes of "Brand Extension" and "Brand Extensions," while thematic clusters unravel six major domains, including brand strategy, ecosystem dynamics, metrics insights, consumer behavior interplay, brand image and service, and feedback effects of brand extension.

CONCLUSION

In conclusion, our thorough bibliometric examination has revealed a comprehensive overview of parent brand and brand extension research, illuminating its evolving landscape. We have observed the dynamic nature of this field through annual publication trends and the various approaches employed by researchers, evident in the balance between collaborative and individual publications. These findings provide valuable guidance and a rich reservoir of knowledge for researchers, practitioners, and academics navigating the ever-changing realm of brand strategy and innovation.

Implications and Future Directions

The study's findings are pertinent for academics and marketing professionals who are developing branding policies and analyzing consumer behavior, responses, and choices related to branding, brand extensions, and their relationships with parent brands/ core brands. There should be more study regarding the subject, and there is still a lot of uncharted territory to be discovered.

Limitations

In this study, we solely utilized the Scopus database. However, future researchers are encouraged to expand their analysis by utilizing other relevant databases such as "Web of Science." Additionally, some important research may have been overlooked during the database filtering process. Furthermore, incorporating a quantitative content analysis in future studies can provide a comprehensive and theory-driven analysis. Researchers can also explore the use of other tools, approaches, and software such as Gephi, Bibexcel, and others to enhance their research methodologies.

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Table 1: Prominent Details About the Data

Timespan	2004:2023	Average Citations Per Doc	27.96	Authors of Single-Authored Docs	23
Sources (Journals, Books, etc.	92	References	8647	Single-Authored Docs	23
Documents	195	Keywords Plus (Id)	83	Co-Authors Per Doc	2.56
Annual Growth Rate %	-1.5	Author's Keywords (De)	507	International Co-Authorships %	30.77
Document Average Age	9.38	Authors	401	Articles	195

Table 2: Source Analysis

Rank	Sources	Articles	H Index	G Index	M Index	Tc	Np	Acpp
1	Journal of Product and Brand Management	17	11	17	0.579	432	17	25.4
2	Journal of Brand Management	9	7	9	0.467	140	9	15.6
3	Journal of Business Research	9	8	9	0.5	173	9	19.2
4	International Journal of Research In Marketing	7	6	7	0.333	334	7	47.7
5	Journal of Consumer Psychology	7	5	7	0.263	464	7	66.3

Table 3:Scientific Collaboration of Countries

Country	Articles	SCP	MCP	Frequency	MCP_Ratio
USA	34	25	9	0.174	0.265
China	18	12	6	0.092	0.333
Spain	12	6	6	0.062	0.5
Germany	10	5	5	0.051	0.5
India	10	10	0	0.051	0

*MCP- Multi Collaboration Publications,SCP- Single Collaboration Publications

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Table 4: Country Collaboration Analysis

From	To	Frequency
United Kingdom	Spain	5
USA	Canada	4
USA	Chile	4
USA	China	4
USA	Netherlands	4
Germany	United Kingdom	3

Table 5:Authors Analysis

Rank	Authors	Documents	H Index	G Index	M Index	TC	ACPP	NP
1	Sattler H.	6	6	6	0.333	785	130.83	6
2	Bisvert J.	5	4	5	0.267	81	16.2	5
3	Dwivedi A.	5	5	5	0.357	94	18.8	5
4	Merillees B.	5	5	5	0.357	94	18.8	5
5	Volckner F.	5	5	5	0.278	778	155.6	5
6	De Chernatony	4	4	4	0.2	312	78	4
7	Del Barrio Garcia	4	4	4	0.667	76	19	4
8	Hem Le	4	3	4	0.2	115	28.75	4
9	Iversen NM.	4	3	4	0.2	81	20.25	4
10	Milberg SJ.	4	3	4	0.188	95	23.75	4

Table 6:Institutions Analysis

Rank	Organization	Documents	Citations	ACPP
1	University of Southern California, United States	2	276	138
2	CassBusinessSchool, City University,London, United Kingdom	2	148	74
3	NHH, Norwegian School of Economics and Business Administration, Bergen, Norway	2	93	46.5

*ACPP- *Average Citations Per Publication*

Table 7: Publications Analysis

Rank	Authors	Title	Year	Source Title	Cited By
1	Völckner F.; Sattler H.	Drivers of brand extensions success	2006	*Journal of Marketing*	394
2	Monga A.B.; John D.R.	Cultural differences in brand extensions evaluation: the influence of analytic versus holistic thinking	2007	*Journal of Consumer Research*	256
3	Fedorikhin A.; Park C.W.; Thomson M.	Beyond fit and attitude: the effect of emotional attachment on consumer responses to brand extensions	2008	*Journal of Consumer Psychology*	208

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Table 8: Keywords Analysis

Rank	Keywords	Frequency	Rank	Keyword	Frequency
1	Brand Extension	64	6	Consumer Behaviour	15
2	Brand Extensions	58	7	Perceived Fit	11
3	Brand Equity	17	8	Brand Loyalty	10
4	Brand Image	15	9	Brands	10
5	Brand Management	15	10	Advertising	7

Table 9:Thematic Analysis of the Domain

Cluster No.	Cluster Name	Cluster Description	Keywords in Cluster
1.	Brand Strategy and Extension Factors	This cluster examinedthe elements influencing brand growth and reach, including strategic planning and extension determinants.	ADVERTISING, BRAND DILUTION, BRAND EXTENSION, BRAND QUALITY, LINE EXTENSION, PARENT BRAND, PERCEIVED FIT
2.	Strategic Brand Ecosystem: Leveraging Identity, Innovation, and Spillover Effects	This clusterstudies how brand identity, innovation, and cross-effect impacts form an integrated strategic brand environment.	BRAND EXTENSIONS, BRAND IDENTITY, BRAND MANAGEMENT, BRANDING, INNOVATION, SPILLOVER EFFECTS
3.	Brand Metrics insights	This cluster analyzes the measurable indicators to gain a deeper understanding and evaluation of brand performance	BRAND ATTITUDE, BRAND EQUITY, BRAND LOYALTY, PERCEIVED QUALITY
4.	Exploring the Interplay of Brand Personality, Brands, and Consumer Behavior	This cluster Investigates the dynamics of brand personality, overall brand perception, and its effects on consumer actions.	BRAND PERSONALITY, BRANDS, CONSUMER BEHAVIOUR
5.	Brand Image and Service	This cluster explores the dimensions of brand image and the quality of services provided.	BRAND IMAGE, SERVICES
6.	Feedback Effects of Brand Extension	This cluster Understands how extending a brand's offerings can influence the brand itself and its original products or services.	FEEDBACK EFFECTS
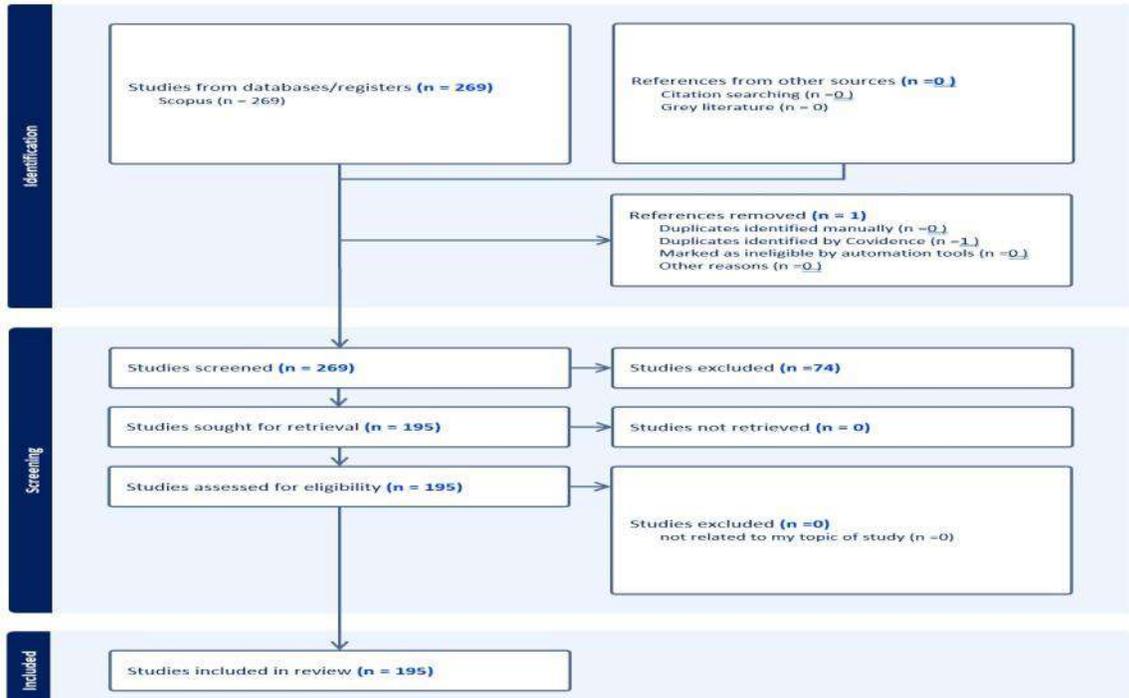
Figure 1: Prisma Protocol Flowchart

Figure 2: Annual Trend Analysis

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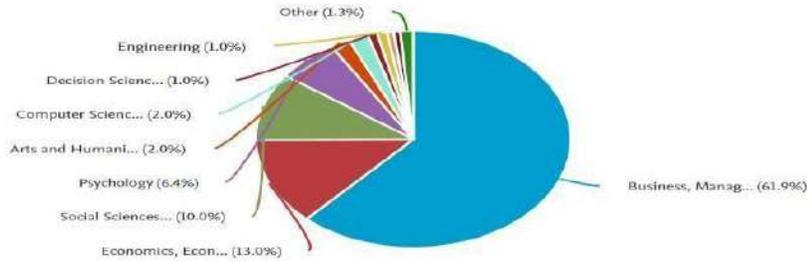
Figure 3: Documents Published by Subject

Figure 4: Country Collaboration Map Using Biblioshiny
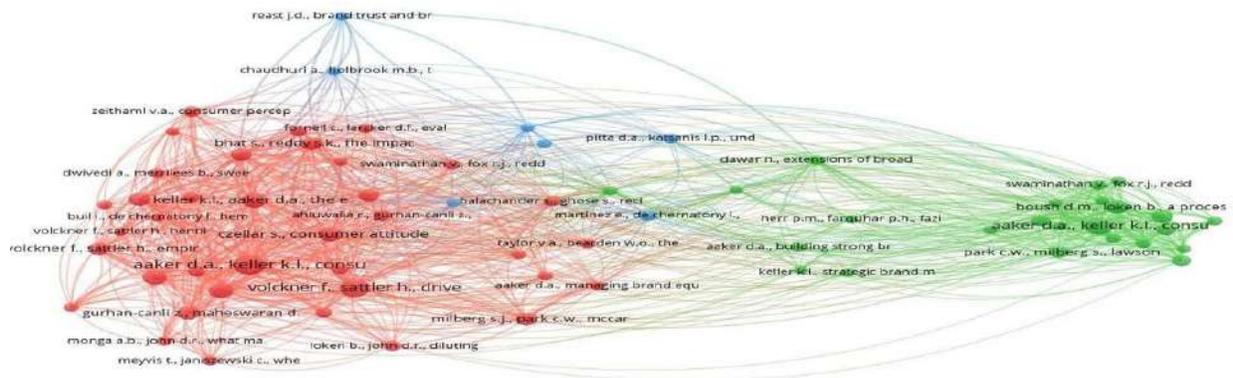
Figure 5: References Analysis Using VOSviewer
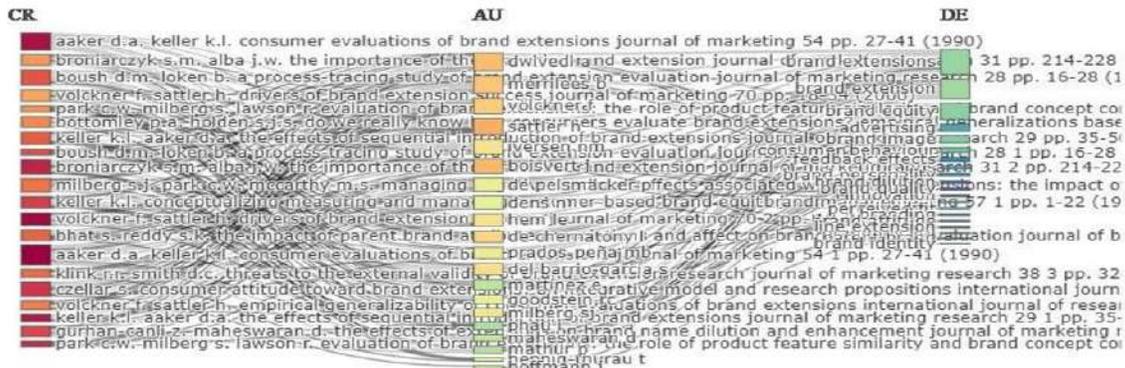
Figure 6: Three Field Plot Analysis
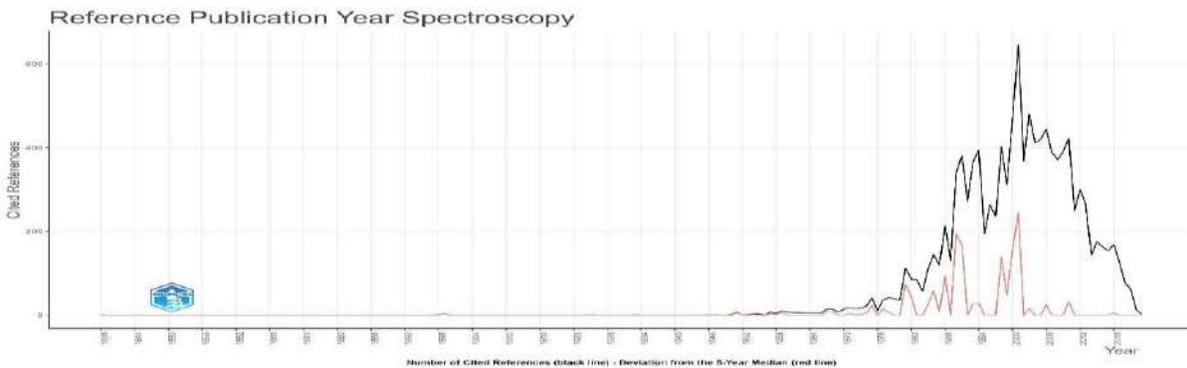
Figure 7: Reference Publication Year Spectroscopy Analysis (RPYS) Using Biblioshiny
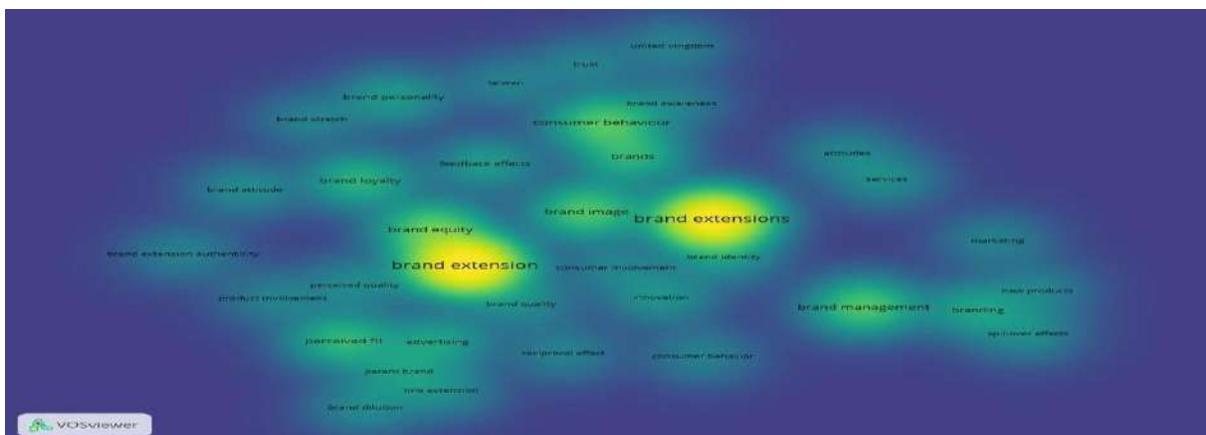
Figure 8: Density Map of the Most Frequent Keywords

REVIEW ARTICLE

Predictive Analytics using Machine Learning: Review of Trends and Methods

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ABSTRACT

Predictive analytics has emerged as a crucial field for leveraging historical and present data to forecast future trends, behaviors, and outcomes. This paper provides an overview of various techniques employed in predictive analytics, showcasing their application across diverse domains. Techniques such as machine learning algorithms, regression analysis, time series analysis, and data mining play pivotal roles in uncovering patterns, correlations, and insights from vast datasets. The discussion encompasses the strengths, limitations, and real-world applications of these techniques, illustrating how predictive analytics aids decision-making processes in finance, healthcare, marketing, and other industries. Furthermore, the paper explores challenges related to data quality, model interpretability, and ethical considerations, underscoring the importance of responsible use of predictive analytics. Ultimately, the work underscores the significance of predictive analytics in harnessing the power of data-driven insights to facilitate informed decision-making and strategic planning in various domains. The review presents an extensive analysis of the diverse techniques employed in predictive analytics, illuminating their evolution, applications, strengths, and limitations. Predictive analytics, a burgeoning field, utilizes a multitude of methodologies including machine learning algorithms, regression analysis, time series forecasting, and data mining.

Keywords: analytics, predictive, techniques, algorithms, finance, healthcare, marketing.

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INTRODUCTION

A comprehensive analysis of past data and patterns to forecast future trends, behaviors, and outcomes. Predictive analytics leverages various methodologies and tools to extract insights from data, enabling organizations to anticipate potential scenarios, make informed decisions, mitigate risks, and identify opportunities. By utilizing statistical algorithms, machine learning models, and AI methods and forecasting analytics examines existent data to uncover correlations, patterns, and relationships. Predictive models are then developed using these insights to foretell future trends, behaviors, or trends. These models can be applied across numerous fields, such as finance, marketing, healthcare, cyber security, weather forecasting, and more.[1] For instance, predictive analytics can be used by a fast-food chain to enhance drive-thrus and shorten wait times for patrons. One such system was effectively created by Folio3 for a client. Their Automated Drive-Thru Verification. The company "Dashcode," which requested the automated system, hoped to apply deep learning and break down each task to increase the workflow efficiency in Drive-Thrus. By doing this, in order to save order time, the system would be able to forecast what customers are likely to order and suggest it first. The use of predictive analytics in e-retailing is not restricted.

It is applicable in numerous fields. To determine the types of working professionals who might be interested in various insurance plans, insurance companies obtain working professional data from external sources. Then, they reach out to these professionals, enticing them with their offerings [2].Banking institutions use predictive analytics models to identify fraudulent customers and credit card risks so they can take the necessary action. Financial investment companies find stocks that have the potential to yield a high coming back to investing, and they even forecast future stock performance based on historical and instant execution data. If they are investing in manufacturing in this way, a lot of other businesses use predictive models to forecast the sales of their products. Pharmaceutical companies can determine which medications are less popular in a specific region and receive alerts when those medications expire. [3] In order to find new trends and patterns, predictive analytics manipulates data from preexisting data sets in specific ways. Future results and trends are then predicted using these patterns and trends. We are able to forecast performance and trends for the future by using predictive analysis.

 Another definition for it is prognostic analysis, where prognostic refers to prediction. Utilizing data, statistical algorithms, and machine learning techniques, predictive analytics determines the likelihood of future events based on past data. Predictive models can anticipate market trends, consumer behavior, and demand patterns, aiding in strategic planning, inventory management, and marketing campaigns. By analyzing historical data, organizations can assess potential risks and mitigate them by making proactive decisions. Predictive analytics helps in understanding customer preferences, enabling personalized recommendations, targeted marketing, and improving overall customer experience. It assists in optimizing processes and resources by predicting equipment failure, optimizing supply chain logistics, or identifying cost-saving opportunities. Predictive analytics plays a vital role in healthcare by predicting disease outbreaks, identifying high-risk patients, and enhancing treatment plans. It also helps in predicting market trends, stock prices, and assessing credit risks. Overall, predictive analytics empowers organizations to anticipate future scenarios, make data-driven decisions, and gain a competitive edge in their respective industries by leveraging the power of data and technology.

PREDICTIVE ANALYTICS PROCESS
Statistical algorithms and machine learning methods are used in predictive analytics to examine past data and forecast future occurrences or results. There are usually multiple steps in the process:

Problem Definition
Clearly state the issue or desired result in your prediction. This step entails figuring out what you want to predict, defining objectives, and comprehending the business problem.

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Data Collection
Collection of applicable data from various sources. This can include unstructured data from sources like text, photos, or videos, as well as structured data from databases, spreadsheets, or APIs.

Data Preprocessing
To ensure its quality, clean the data and get it ready for analysis. In this step, handling missing values, eliminating duplicates, converting data types, and handling outliers are all involved..

Exploratory Data Analysis (EDA)
Explore the data to understand patterns, relationships, and trends. Visualization techniques and statistical analysis help in gaining insights into the data and identifying important variables.

Feature Selection/Engineering
Select the most applicable properties (variables) that are intended to be used to build the predictive hypothesis. Feature engineering may involve creating new features or modifying current ones to enhance model functionality.

Model Selection
Select the right predictive modeling technique based on the nature of the problem and the available data. Common techniques include linear regression, decision trees, random forests, support vector machines (SVM), neural networks, etc.

Model Training
Use historical data to train the selected model. This involves feeding the algorithm with labeled data (input and output pairs) to learn patterns and relationships.

Model Evaluation
Assess the performance of the trained model using evaluation metrics suitable for the specific problem (e.g., accuracy, precision, recall, F1-score, ROC curves). This step helps in understanding how well the model generalizes to new, unseen data.

Model Tuning
Fine-tune the model parameters or hyper parameters to modify its execution. To identify the ideal parameters, methods such as grid search and cross-validation can be applied.

Deployment
Put the model into use so that it can forecast fresh data when it arrives in production. This can entail building an interface through which users can communicate with the model or integrating it into already-existing systems.

Monitoring and Maintenance
Endlessly supervisor the model's performance in real-world scenario. Periodic modification and retraining might be necessary to ensure the model's accuracy and relevance as new data becomes available or the business environment changes. To make sure the model solves the business problem and offers insightful information for decision-making, domain experts, data engineers, data scientists, and business stakeholders must work together throughout this iterative process.

LITERATURE REVIEW

An important area of research is predictive analytics of energy usage by Internet of Things-based smart home appliances, for green urban development. Various machine learning techniques and algorithms have been used to

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develop predictive models for energy consumption in sophisticated arrangements. These models consider variables like overall energy consumption, energy demand, and weather. The aim is to find the best-suited technique with a low error rate for predicting energy consumption in smart homes. The use of renewable energy sources and micro grids in institutional settings has also been explored to optimize energy usage and reduce carbon emissions. These studies offer important new insights for accurately predicting and controlling building and urban areas.[4] A prediction model for building energy consumption is built using a multi-optimization model. The model makes use of several optimization algorithms, including the Bayesian Optimization Algorithm (BOP), Particle Swarm Optimization (PSO), Simulate Anneal Arithmetic (SAA), and Sparrow Search Algorithm (SSA).[5] Another approach involves using a recurrent neural network and a multi-task learning model to predict building energy consumption. This method allows for the parallel prediction of multiple types of energy consumption, improving prediction precision and speed [6] Predictive analysis using machine learning has gained significant attention in recent years. It entails analyzing past data and forecasting future results using machine learning algorithms.. Various methods and trends have been identified in this field. For example, decision trees (DT) and artificial neural networks (ANN) are commonly used in education . By application area, the study focuses on the most widely used techniques: LR, RF and DT in building, DT and ANN in education, RF in social science, RF in medicine, and DT in botany..[7]. By application area, the author focuses on the most widely used techniques: LR, RF and DT in building, DT in botany, RF in social science, and RF in medicine. In construction, random forests (RF), logistic regression (LR), and decision trees (DT) are widely used. [8] Using the Random Forest and Support Vector machine learning algorithms, the authors' machine learning prediction of loan approval and credit card fraud detection achieved 92% accuracy.[9] A machine learning algorithm was developed that used feature selection and ensemble techniques to yield positive results, with an accuracy rate of 90.24 percent achieved. This demonstrates the potential of predictive analysis in cardiology and the significance of utilizing patient data to create more effective treatment regimens..[10]

The authors proposed a model that utilizes actual datasets, which In order to forecast the unemployment rate. The datasets were examined using machine learning models such as LSTM and Linear Regression..[11] The provided paper is about the development and evaluation of machine learning algorithms for predicting adverse drug reactions. It does not provide information about other research papers on predictive analysis using machine learning. A paper explores the use of machine learning algorithms, including SVM, Random Forest, and Gradient Boosted Trees, to predict adverse drug reactions using databases such as SIDER and OFFSIDES.[12] The paper discusses how predictive analytics, machine learning, and deep learning are used together to automate predictive modeling and identify patterns, trends, or future outcomes. Predictive analytics has revolutionized various sectors, such as finance, healthcare, retail, and manufacturing. Machine learning and deep learning algorithms automate predictive modeling for future outcomes.[13]

CONCLUSION

A review of the literature on ML trends and techniques for predictive analysis is provided in this study. We used a method that allowed us to choose only the most recent studies in order to conduct a reevaluation that accurately reflects the current state of the field.

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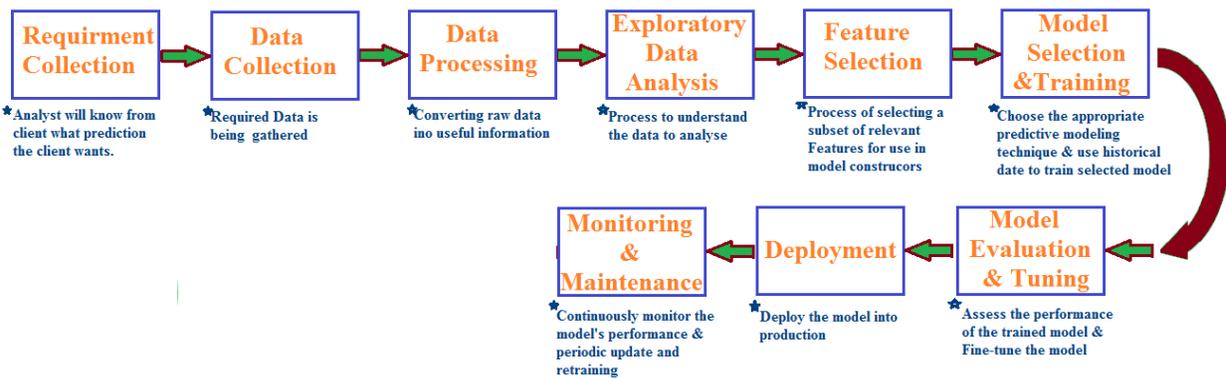
Figure 1: Predictive Analytics Process

RESEARCH ARTICLE

An Optimized Framework for Social Internet of Things

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ABSTRACT

The intersection of social networks and the Internet of Things (IoT) has given rise to a technology known as the Social Internet of Things (SIoT). Basically, Social Internet of Things isa concept which establishes connections between objects and human beings based on the principles, set by their respective owners. In this context, users within social networks assume the dual role of both service demanders and providers. In contemporary applications, maintaining trust among interconnected devices is a complex undertaking; crucial for the development and establishment of trust management system. This work introduces architecture of Quality of Services to effectively manage trust between IoT devices. The proposed framework focuses on enhancing the current process of trust and reputation building. Furthermore, service context parameters will be employed to standardize the judgement behavior. Alongside, this study presents co-location, co-device and co-work metrics such as delay, demand-supply accuracy, feedback etc. Further, an optimization approach is implemented to enhance the performance of the trust management system.

Keywords: Social Internet of Things, Internet of Things, Artificial Intelligence, Quality of Service, Feedback, Optimization.

INTRODUCTION

The Internet of Things (IoT) refers to a network comprising of interconnected and diverse devices, objects, and machines, each of which are uniquely identifiable. This network facilitates the transfer of data autonomously, eliminating the necessity for direct human-computer or human-human interaction. The utilization of Internet of Things has broadened its scope across various sectors, including consumer, commercial, and industrial domains. Within the consumer realm, IoT applications have prominently found their place in smart home systems, innovative healthcare solutions, and wearable devices [1].Future IoT applications are expected to be developed using a service-oriented architecture, wherein each device has the capability to function as a service requester or service provider. IoT can be characterized as collection of devices with the ability to communicate using diverse protocols. IoT is evolving towards a paradigm where interconnected entities seek one another to deliver composite services for

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human beings benefit. In this interaction model, it is crucial to understand how information from individual entity can be automatically processed by any peer within the system. The convergence of social networks with the Internet of Things (IoT) has led to the emergence of a technological concept known as the Social Internet of Things (SIoT) [2,3]. The Social Internet of Things establishes connections between objects and human beings. The architecture of Social IoT has obtained a significant popularity due to its service-oriented architecture and feedback-based design. Social IoT represents a community of users interconnected within a social environment obtaining services from trusted individuals. The architecture of Social Internet of Things (SIoT) can be perceived as a network comprising n users, where each user has access to k services and is subject to t policies for the selection of services from other users. Due to large number/ of services exchanged among devices poses a challenge in selecting appropriate services, leading to the emergence of service recommendation systems.

Conversely, researchers have shown considerable interest in leveraging social relationships among humans to construct sophisticated recommendation systems. Individuals are inclined to share resources with members of their social circles, location or relation and may rely on recommendations received from another entity, particularly those who share similar interests [4].The seeker will broadcast its requirements as a service request to nearby individuals. Each user on the list is already associated with a specific service orientation in the queue and has multiple sets of queries to process.The service requester will transmit a request which contains a two-bit message. The first bit indicates the action's state, with 0 representing rejection and 1 representing acceptance, while the second bit signifies the processing cost. The service provider's selection will depends upon various factors such as co-location, co-relation, co-work, feedback etc.If two devices are situated in close proximity, the service provider will gain advantage of one units..in the overall system. In the initial stage, when the service seeker lacks any record of the service, service orientation is carried out comprehensively. As the SIoT network is activated and service contexts are generated, the records reflect the performance in terms of Quality of Service and a feedback-based mechanism. This information is then used to provide positive or negative rewards to the service provider, forming a system known as reward generation or trust evaluation. In this work, the social relationships, same location, feedback (direct/ indirect), demand and supply accuracy etc are used to create service recommendations among devices, thereby improving service discovery and composition.

LITERATURE REVIEW

A solution for users to choose services from their peers can be found in the architecture of the Social Internet of Things. The existing work focused on obtaining a comprehensive range of services with a strong emphasis on trustworthiness some of the studies are discussed in this section to find out the facts. **Chen et.al .**have introduced and explored the concept of Adaptive Trust Management (ATM) design for SIoT systems [5], where social interactions among IoT device owners evolve dynamically. In this design of the ATM protocol, the authors demonstrated the correlation between convergent value and fluctuation resulting from trust. The adaptive TM protocol can be utilized by the developed IoT application to flexibly determine the appropriate configurations of trust parameters, ensuring accurate trust assessments and optimal application performance. Additionally, the practicality of the proposed technique is evident through the table-lookup method for dynamically analyzing results, considering real-case scenarios. While the results were noteworthy, achieving convergence trust remains challenging due to fluctuations. Um et.al. have presented a framework based on trust-oriented technique for converged management [6]. This work outlines an architecture focused on trust management, incorporating a comprehensive reference model based on IoT. This platform incorporates trust agents, brokers, and management systems to facilitate reliable and secure interactions between individuals and real-world objects. By reducing transaction costs and removing uncertainties in data transactions, the platform enables the creation of a trustworthy environment, fostering the activation of social IoT enterprises. However, this model is applicable for limited applications.

Sagar et.al. introduces a mathematical model for trust. The extraction of specific trust aspects within an S-IoT environment and the determination of an average percentile rank involve aggregating all trust features using a

machine learning-based algorithm [7]. Simulation results demonstrate the effectiveness of the proposed trust-based paradigm in effectively distinguishing between the network's trusted and unreliable nodes in the S-IoT. In this context, IoT devices operate as autonomous agents intelligently exchanging information and discovering new services through the establishment of social connections with each other and their respective hosts. Additionally, the trust model aids in developing trusted links between physical items and mitigating potential risks during the decision-making process. Gheisari et.al. proposed a three-module architecture based on ontology is to address trust and heterogeneity issues. To manage these concerns while safeguarding private information, the initial module is employed for data storage [8]. The second module integrates semantics to identify abnormal patterns and simultaneously deals with service quality. The third module encompasses a security system that tackles the privacy challenges of IoT devices by dynamically adjusting the privacy behavior of these devices. Simulation results on a dataset illustrate that the proposed approach surpasses current solutions.

Guo et.al. have categorized trust evaluation models for managing services in service-oriented Internet of Things (IoT) systems [9]. This study classifies existing model based on five design dimensions: composition, propagation, update, aggregation, and formation. This work also presents a summary of the advantages and disadvantages associated with each dimension and demonstrate the effectiveness of defense mechanisms against malicious attacks. The primary focus of this work lies in illustrating the social relationships among distributed IoT entities and their impact on trust relationships. Parveen et.al. have proposed framework aimed at ensuring secure communication within social networks to establish a reliable and protected user environment. This research utilizes the relationship attribute to assess interactions among virtual objects, specifically designed for security, with feedback analysis conducted on-demand by users. The hybrid ontology-based framework, incorporating kernel functions, undergoes evaluation against two prevalent attack scenarios: DDoS and Malware. The assessment criteria encompass successful communication, observed success rate, trustworthiness, and execution time [10]. The proposed framework exhibits promising potential for future developments, particularly in terms of refining the training architecture and selecting attribute sets for training purposes. A noteworthy avenue for exploration involves introducing neural networks with increased data, achievable through Monte Carlo simulation, to gauge potential quantitative parameter variations. Perera et. al. have examined various research projects in the field of context-aware computing and assessed their capabilities in addressing issues raised in the Internet of Things (IoT) [11].

Out of these, 15 research projects specifically consider the quality of context as a feature. These projects emphasize context-awareness from an IoT perspective, providing insights into the background of the IoT model, context-aware fundamentals, and their connections to sensor networks. This work focuses into the basics of context-aware management design by comprehensively reviewing various methods, approaches, models, functionalities, and applications. Context-aware computing enables users to store context information related to sensor data. Notably, the analyzed articles lack specific coverage of techniques related to data processing and management, which are fundamentally crucial for embracing IoT. The role of sensor networks in the IoT is extensively examined, with a focus on the relationship between IoT and sensor networks. It is worth noting that all these studies primarily concentrate on academic research rather than market solutions. Liu et al. have addressed the challenge of addressing Service Composition (SC) has been effectively tackled through the integration of diverse Quality of Service (QoS) parameters. Additionally, an algorithmic simplification has been achieved by employing a hybrid version of multiple group Genetic Algorithms (GAs) [12]. This process entails transforming the population into subgroups, thereby streamlining the algorithm. Researchers have implemented an enhanced GA algorithm, which combination of Genetic Algorithms with Ant Colony Optimization (ACO) algorithms, to more efficiently tackle SC problems. The results indicate that the proposed improved GA not only resolves SC issues within the context of the Internet of Things (IoT) but also exhibits superior convergence speed when compared to a straightforward ACO approach. It has been found that the trust management system has obtained popularity because of presence of large number of Internet of Things systems in the communication [13]. Within the service-oriented paradigm, there typically exists a seeker and a supplier. In scenarios where a single supplier is available, the seeker is obligated to obtain services from the sole provider. However, in situations involving multiple service providers offering the same service, it becomes

imperative for the network to discern and select the optimal provider [14,15]. If the service provider is unable to provide the suitable service the seeker's requirements could result in a significant waste of time and energy[16].

Proposed Methodology

The assessing of trust model will require feedback architecture as high positive feedback will lead to more trust but when include parameters such as co-work, co-location, co-device and co-relation, the equation will change automatically. Further, the usage of Swarm Intelligence (SI) results in betterment of existing architecture. The proposed work is divided into two parts. The first part represents the separation of data which is done on evaluation of Quality of Service (QoS) and the second part is training and classification of data set. The three levels of methodology are as follows:

1. First the collected data set is analyzed on the basics of Quality of Service (QoS).
2. Secondly, the data is aggregated.
3. Thirdly, the trust is generated using the Machine leaning approach.

The work flow of the proposed methodology is illustrated as below: In order to furnish services to the system, parameters such as co-work, co-location, co-device, co-relation, feedback, QoS, etc., are considered. If more than two users share the same location, the provider will receive a contribution of 0.10 points toward the total rewards. Similarly, the co-work parameter signifies users working in the same location. Co-device refers to two or more users employing the same device, and co-relation indicates that two or more users are already acquainted through some reference. For each type of co-relation, the service provider will be rewarded with 0.10 points. In the simulation of ten thousand service orientations for a sample of 50 services, a total submission request of 530,000 has been generated. In the proposed work, Artificial Bee Colony (ABC) represents a meta-heuristic approach primarily designed to seek out food sources abundant in nutrients and close to the hive. So ABC approach is applied for formation of clusters. From these clusters, groups are formed and labeling (Good and Not recommended) is done. The classification and training is performed with the help of Machine Learning (ML) approaches such as Support Vector Machine (SVM), K-Nearest Neighbor (KNN) and Artificial Neural Network (ANN).The ABC processing architecture that is illustrated as follows: In ABC approach, number of Employed Bees are same as number of food sources. Each solution gets equal opportunity to generate new solution. So, first the objective function is evaluated and fitness vector is generated for the new solution. If the newly generated solution, is optimal solution then pass the results to ML approaches to get better result in case, the solution is not optimal then we will iterate to select random variable and partner so as to get new location of the food source and the iteration repeats until we get best optimal solution.

RESULTS

The results have been evaluated by assessing the rank through the implementation of the Artificial Bee Colony algorithm, metrics like true positive (tp), false positive (fp), and class accuracy comprising of tp, true negative (tn), false negative (fn), and fp are computed to evaluate the algorithm's performance, distinguishing between high and low categories. These metrics are widely employed in the realm of machine learning and classification to measure the efficacy of an algorithm. It quantifies the ratio of accurate predictions (including True Positives and True Negatives) to the overall number of instances in the dataset. The accuracy is computed using the formula:

$$\text{Class Accuracy} = \frac{(tp+tn)}{(tp+fp+tn+fn)} * 100$$

Thus, the accuracy is obtained by adding the count of true positives and true negatives and then dividing this sum by the total number of instances. It yields a singular percentage, serving as a comprehensive measure of the ABC algorithm's proficiency in classifying ranks. A higher accuracy signifies that the ABC algorithm is effectively working

well in classifying as high rank and low rank instances. Accuracy may not suffice for evaluating metric performance. So, additionally include supplementary metrics such as precision, recall and F1-score are included to achieve a more thorough comprehension of the algorithm's performance. These metrics offer insights into the algorithm's capacity to manage fp and fn, contributing to a more subtle assessment of its effectiveness.

CONCLUSION

Social Internet of Things is a concept that establishes connections among objects and human beings, based on the principles set by their respective owners. This work presents architecture and uses various relationship attributes and feedback for reward generation which is inspired by the natural computing framework. Various Machine Learning approaches are used for the classification and training. The proposed framework is optimized using Artificial Bee Colony Approach. The result clarifies that the accuracy alone may not work well for estimating the metric performance. So, additional metrics such as precision, recall, F1-score etc help to achieve the better performance.

DECLARATION OF CONFLICTING INTERESTS
The author(s) declared no potential conflicts of interest with respect to the research, authorship and/or publication of this article.

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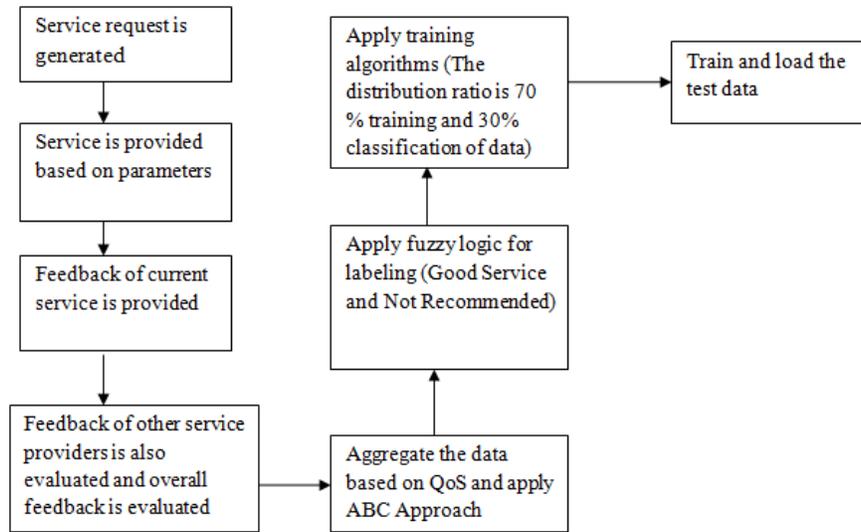
Fig.1.Workflow of Methodology
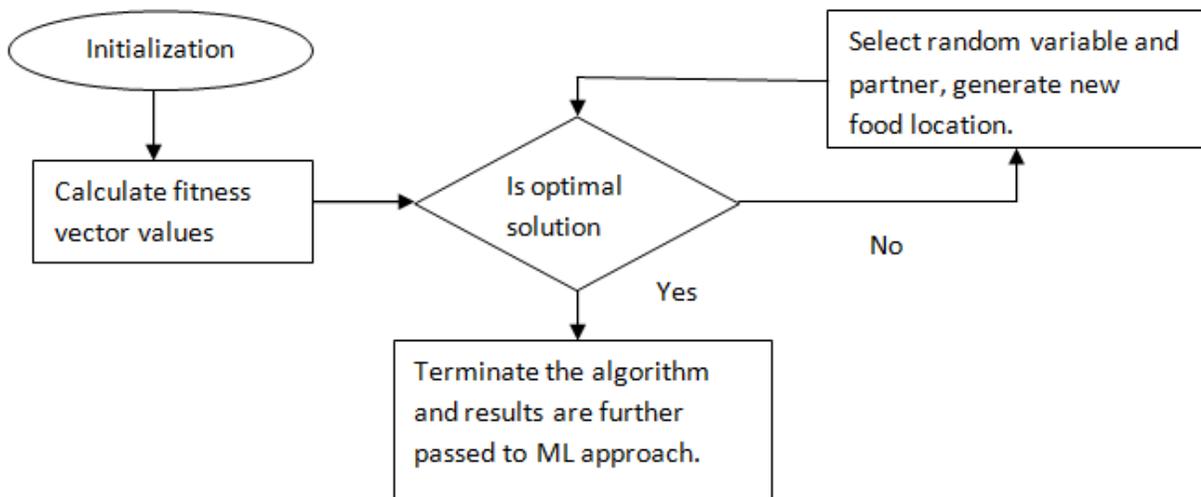
Fig.2. ABC Architecture

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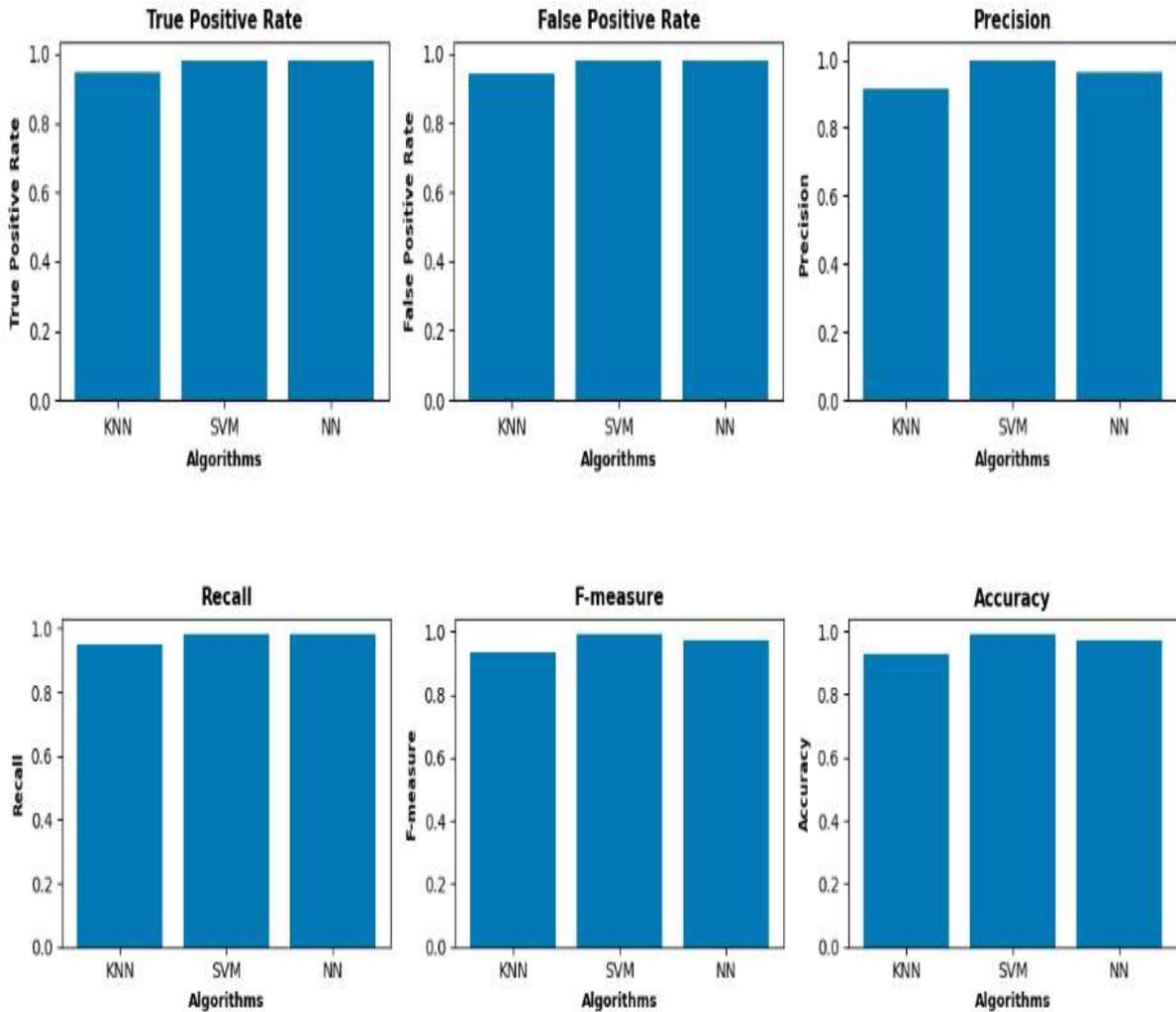
Fig.3. Analysis of Performance

RESEARCH ARTICLE

CeSnMoP as Catalyst in Biodiesel Production Via Castor and Waste Sunflower Cooking Oil: A Comparative Study

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ABSTRACT

Biodiesel has replaced conventional petroleum and diesel oil due to less emission of carbon dioxide gas. Several methods are known for biodiesel production using vegetable oil, viz: palm, jatropha oil, etc., which are expensive sources for its production. So, in search of an affordable option, castor oil and waste cooking oil have been used for biodiesel production. In this study, a comparison between castor and sunflower waste cooking oil is reported for biodiesel production using a trans esterification process showing desirable properties. Several fuel properties such as viscosity, density, aniline point, acid value, flash, fire point, pour & cloud point, and calorific value were also compared, for which ASTM standards were considered. The catalyst cerium (IV) tinmolybdo phosphate [CeSnMoP] was used in 3(w/v)% having an oil(v) to methanol(V) ratio (1:9) to represent optimized parameters. The catalyst CeSnMoP has a surface area of 194.302 m²/g, which was determined using the BET equation in nitrogen adsorption. The observed calorific values of castor (CS) sunflower waste cooking oil (SWCO), biodiesels were 3207 and 5204 Kcal/kg, respectively. A remarkable % yield of the biodiesel derived from sample oil (CS & SWCO) was ~ 89.95% and ~ 94.05%, respectively.

Keywords: Cerium (IV) tinmolybdo phosphate, Trans esterification, Sunflower waste cooking oil, Castor oil, Catalyst loading, Biodiesel

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INTRODUCTION

In green chemistry, biofuel is the easiest and purest available fuel on Earth. Bio-fuel can be produced by various organic matter like agricultural wastes, straw, sludge, waste vegetable oils, sewage, etc. through the process of either digestion or fermentation [1-2]. Out of all these fuel types; biodiesel is considered the most reliable one. It is considered a handy and viable fuel as it enhances the power, performance, and economy of the nation [3], It also has very less emissions of greenhouse gases, particularly CO_2 gas thus helping in reducing global warming. Moreover, it is found to be non-toxic at all and very safe to use. It brings a healthy balance in energy and security for fuel [4]. It is biodegradable and the former wastes can be recycled. Biodiesel helps in the economic development of the community by saving money utilized on other fuels [5-6]. Numerous options for the raw materials of biodiesel are available from which castor and waste cooking oil are better options. Castor oil is a non-edible vegetable oil that is low in cost and high in quality such as; it has a high amount of ricinoleic acid ($C_{18}H_{34}O_3$) possessing ~80-90% fatty acid, and its trans esterification can be completed with methanol which results in low production cost and low emission of greenhouse gases [7-8]. Waste cooking oil has proven to be another great option for biodiesel production as it leads to environmental and waste management which is a very serious discussion nowadays.

This management further leads to economic benefits [9]. The biodiesel produced using waste cooking oil through a trans esterification process has been found better in terms of properties; density, viscosity, acid value, pour, cloud point, flash, fire point, etc [10-12]. Therefore, researchers are engaged in the mentioned activity using different types of homogeneous and heterogeneous catalysts like alkaline, acidic, nanomaterial, etc. A homogenous alkaline transesterification process of castor at ~ 65°C temperature and the time for reaction is ~ 8 h giving a yield of ~ 73.62% (w/w) stated by Dias et al [13]. Similarly, Karmakar et al reported the use of a homogeneous acid catalyst where ~ 90.83% FFA conversion was attained under these optimized conditions; reaction temperature ~ 50°C, duration of 1 hour, concentration of catalyst ~ 1% w/w, methanol to oil ratio of 20:1 and agitation speed of 700 rpm [14]. Gohar Khan et al reported the mussel shell-based CaO nano-catalyst which was doped with praseodymium to improve the production of biodiesel yield of 87.42% by 7 % by trans esterification of methanol and castor oil [15]. Other renewed technology includes hydrodynamic cavitations with a yield of 92.3% using castor oil [16], Blend of fish along with castor oil to produce biodiesel [17], blending of oil-suitable blends in castor oil-based biodiesel to enhance the engine performance [18]. Similarly, CaO heterogeneous catalyst derived from waste chicken eggshells gave a yield of ~ 98.62% using waste cooking oil [19].

A lipase enzyme biocatalyst with a magnetic hybrid sol-gel nano composite was successfully employed by Parandi et al to derive biodiesel using a waste form of cooking oil [20]. On the other hand, Farvardin et al followed an ultrasonic-hydrodynamic combined cavitations system to increase the yield of biodiesel [21]. $MgO/MgSO_4$ nanocatalysts were utilized by Bora and his team members to yield ~98.8% biodiesel thiourea-nitrate solution [22]. Heteropoly acids/ salts are strong Bronsted acids having marvelous catalytic features. Biodiesel production using heteropoly acid salts includes: tin exchanged heteropoly acid supported by titania nanotubes were procured to produce biodiesel from levulinic acid and furfuryl alcohol [23]. Sn(II) supported Kegginheteropoly acid was used for the etherification of glycerol along with tert-butyl alcohol [24]. $Cs_2H_4PV_3MoW_8O_{40}$ catalysts were used in a trans esterification reaction where methanol/oil molar ratio of 30:1 leads to a conversion rate up to 92.2% [25]. Phosphotungstic acid submerged in a framework of zirconium metal-organic nano composite and whole set was co-doped with ammonium and silver-catalyzed Lauric acid trans esterification giving a yield of 75.6% [26]. Therefore, in this report, biodiesel production from CS, as well as SWCO oil in the presence of CeSnMoP, a heterogeneous catalyst utilizing the transesterification process, has been carried out. Their corresponding properties have been analyzed to explore the best preparatory conditions. The focus of this study is biodiesel production with maximum % yield under operational conditions and at the best standards. A comparison of these two types of oils is also described to derive optimum conditions for biodiesel using the mentioned heteropoly acid salt as a catalyst.

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MATERIALS AND METHODS

Required materials and instruments

Sunflower waste cooking oil (collected from a local shop), Castor oil (Nice chemicals pvt. ltd.), methanol (CDH), synthesized heteropoly acid salt [CeSnMoP] as a catalyst, Ostwald's viscometer, Pensky Martin's close cup flash point apparatus standard: IP 34, ASTM D 93, IS 1448 (P-21), ISO 2719, Bomb calorimeter (Test method: ASTM-D5865-98a), Pour point analyzer (IS 1448, P:10), BET surface area analyzer (AutosorbiQ Station 1) with accuracy > 0.15% of reading.

Preparation of stock feed

SWCO was purified via filtration and then other sticky wastes were removed using starch as a coagulant [27]. Castor oil was used as it was available without any adulterations.

Trans-esterification Process

In this process, biodiesel is produced by transesterification of triglycerides and alcohol in the presence of heteropoly acid salt, CeSnMoP. A generalized procedure followed in the present report: Raw vegetable oil was mixed with a calculated quantity of catalyst and methanol, then refluxed for a specified period. Each refluxed mixture was kept in a separating funnel overnight. Two distinguished layers appeared containing biodiesel as the upper one and (glycerol + catalyst) as the lower layer. FTIR of the samples was done at the initial stage to confirm the formation of biodiesel.

Raw Vegetable Oil + Alcohol $\longrightarrow$ Biodiesel + Glycerol
$$\text{CeMoSnP}$$
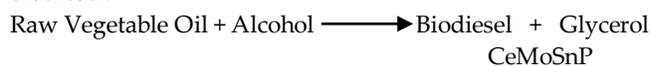
Fatty acid methyl esters (FAMEs) possess properties similar to diesel. The production of FAMEs results in the production of glycerol as a side product, which is an essential ingredient in the production of soaps, lubricants, and similar products. The production methodology for biodiesel is presented in Figure 1, which provides a detailed overview of the process. By analyzing the impact of diverse variable parameters on two distinct types of oil processing, we were able to optimize the reaction conditions. This careful approach allowed us to achieve the utmost efficiency in our process, ensuring that we produce high-quality biodiesel with the lowest possible environmental footprint.

Catalyst loading

The amount of Catalyst employed in a reaction always affects the rate of reaction as it offers the surface area to the reactant. Therefore, this parameter was optimized. Different % ages of catalyst varying from 1% to 5% were tried for a ratio 1:9::oil: alcohol to sort out the appropriate condition for biodiesel production. Then all these five samples were refluxed for a reaction time of 6 hrs at the reaction temperature of 80℃. Relevant outputs for the selected samples in the case of CS and SWCO are given in (Figure 2) and when the reaction was over, bio-fuel was separated by following the already mentioned procedure. The catalyst used in the reaction rejuvenated after filtration and was followed by required washing.

Reaction temperature and oil: methanol ratio

Excess methanol is found good for breaking fatty acids and glycerin linkages, hence higher oil: methanol ratio was found better for more conversion of alkyl esters in very less time. So, it could be observed that the oil: methanol ratio plays a vital role in the trans esterification of biodiesel. In this report, the selected ratio of oil: alcohol with catalyst proportion 3(w/v) % was subjected to study the effect of variable reaction temperatures i.e., 60, 70, and 90℃ on each ratio of (oil: methanol) (1:7;1:8;1:9;1:10) for a constant duration of 6 hrs. A similar procedure was followed for both types of oil and then the impact of reaction temperature was also considered to optimize the reaction parameters by adopting the methodology as given in figure 1 and the results are represented in {Figure 3 (a & b)}.

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Reaction time

The fourth parameter is reaction time (hrs) whereas the oil: methanol: catalyst, reaction temperature(℃) and catalyst % were kept constant. The effect of various reaction times (4,5,6 and 7 hrs) was observed for these two types of biodiesels. The resultant data is expressed in (Figure 4).

Various characteristics of biodiesel under study (Figure 5)

1. Density of biodiesel can be determined using a pycno meter (25 ml) at room temperature ~ 23℃ on those days. Density was calculated in units gm/ml.
2. Dynamic viscosity: This property of biodiesel was determined w.r.t. distilled water by using Ostwald's viscometer. By using the formula and technique described by Camas-Anzueto et al. [28].
3. Acid value: Titration of biodiesels (CS and SWCO) for each ratio was done to find their respective acid values using standard NaOH [29].
4. Aniline point: It is the minimum temperature at which equal volumes of oil and aniline form a single phase [30]. In the present study, a minimum temperature point was noticed where two distinguished phases were observed on cooling a preheated equal-volume mixture of oil and aniline.
5. Flash point & Fire point: These properties of biodiesel indicate the temperature tolerance and the condition to ignite fuel in an engine. The higher the temperature higher the vapour pressure which increases the concentration of vapours of combustible liquid in the air [31-32]. Both these properties were determined with the help of "Pensky Marten's Flash Point Apparatus"
6. Cloud point & Pour point: Generally, it is termed as the temperature at which there is an appearance of cloudiness in the biodiesel. Lower is the cloud point of biodiesel, the better it is considered [33]. On the other hand, the pour point of a fuel is considered the temperature at which it solidifies and is not capable of flowing anymore [34]. This parameter was also studied to prove its viability.
7. Calorific value: Calorific value is the amount of heat a substance produces after complete combustion [35]. It is measured and calculated using the bomb calorimetric technique.

RESULTS AND DISCUSSION

Trans-esterification reaction was carried out several times under variable conditions i.e., catalyst loading, oil to alcohol ratio, temperature, and reflux time. Observations regarding the various properties of prepared biodiesel are given as:

Effect of catalyst loading

After conducting extensive testing on five different catalyst conditions, it was determined that the composition with 3% (w/v) was the clear winner in terms of percentage yield. As a result, this composition was immediately selected for further studies. The percentage yield of biodiesel was meticulously observed for CS and SWCO biodiesels, with catalyst loadings ranging from 1% to 5% (w/v), as detailed in (Figure 2).

Reaction temperature and oil: alcohol optimization

Optimization of reaction temperature and ratio of oil: alcohol variation on various properties was done keeping the reaction time (6 hrs) and catalyst loading 3 (w/v)% fixed in the case of both CS and SWCO biodiesels. Four different temperatures were tried i.e., 60, 70, 80, and 90℃ on every ratio of oil: methanol i.e.,1:7;1:8;1:9;1:10. % yield of biodiesel was also measured during this variation; in the case of CS, it was observed that with the increase in alcohol content, the % yield increased up to 1:9 ratio and then again showed a downfall in case 1:10 ratio as seen in {Figure 3(a)}.Almost similar are the results for SWCO, although the % yield did not show much variation. The Results are given in {Figure 3(b)}.

Impact of reaction time

Reaction time is also a parameter to define the quality as well as yield of the biodiesel. As observed by the above study the ratio 1:9 of CS and 1:10 of SWCO gave the best results and hence these are selected for further study. The reaction time of the trans esterification reaction was kept variable (4, 5, 6 and 7 hours) for both types of biodiesel synthesis and was attained by keeping a constant reaction temperature of 80°C along with subjecting the reaction mixture to trans esterification for a different period at a constant ratio of catalyst i.e., 3%. Results are represented in (Figure 4). By looking at these graphs it can be observed that most of the properties have shown better response for SWCO than CS at different times of reaction. An increase in reflux (reaction time) also increased the % yield of these products.

FTIR of these trans-esterified oils

 FTIR of the trans-esterified product after purification indicates the presence of characteristic peak of ester (biodiesel) 1720 cm⁻¹. This proves that the catalyst is working efficiently in the described reaction. Results are given in (Figure 6; a & b). Hence confirm the formation of desired product validate the path followed to obtain the product.

Analysis of various properties of resultant biodiesel

The resultant selected biodiesel samples were tested for different properties like Density, Dynamic viscosity, Acid value, Cloud point, Pour Point, Fire pint and Flash Point. A low value of Density, viscosity and acid value favours the formation of biodiesel from waste cooking oil. Similarly, a lower temperature for cloud and pour point also points towards SWCO. Although the fire point did not show any discrimination in values. Studies for cloud points were done to verify the oil legality. The cloud point of the SWCO biodiesel was too low to measure by thermometer and hence measured by using an ultra cool refrigerator available in the lab. For SWCO pour point of a selected ratio was determined with the help of the Pour Point Analyzer (IS 1448, P:10) using the test method. In conclusion, we can say that the oil: alcohol (1:9) for CS and for SWCO were found with the best of it and hence selected for further analysis. It was also observed here that the % yield of biodiesel production was increasing w.r.t rise in reaction temperature and oil: alcohol.

Calorific value

The gross calorific values of the finally selected samples of both types of biodiesels were determined by using test method ASTM-D5865-98a in unit Kcal/kg. The combustion bomb can withstand a pressure of 20Mpa possessing more than 99.5% oxygen. The Calorific values of CS and SWCO biodiesel was found to be 3207 and 5204 Kcal/kg respectively. The higher the statics for calorific values more efficient are the biodiesel. So, these results clearly show that the SWCO biodiesel is showing more competent results than CS biodiesel.

Percentage Yield of biodiesel

The percentage yield of a sample explains the total percentage production of the required biodiesel. The formula used for the following calculation is as under [36]: Biodiesel % age yield = (weight of biodiesel / weight of initial oil sample) ×100 in the case of castor oil (CS) biodiesel, the overall highest % yield obtained (for the selected ratio) is ~ 89.95% while for sunflower waste cooking oil (SWCO) biodiesel the % yield (for the selected ratio) is ~ 94.05% which also indicates about more efficiency of waste cooking oil biodiesel (SWCO). In other ratios the % yield variation in the range of ± 1%.

BET surface area analysis

To find the adsorption rate of the same catalyst and the gas-solid interface of the resulting products, the surface area of the catalyst was measured [37]. BET surface area analyzer (AutosorbiQ Station 1) was used here in a nitrogen adsorption which was calculated as 194.302 m²/g for this catalyst cerium (IV) tinmolybdo phosphate. Sample weight was found 0.2478 g under nitrogen atmosphere and the bath temperature noted was ~ 77.35 K. Langmuir isotherm is one of the simplest technique for monolayer physical adsorption of liquids or gases applicable only in ideal conditions [38]. The Langmuir plot describing the surface area of this catalyst which is given below in (Figure 7).

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Rejuvenation of catalyst

Upon completion of the trans esterification process, the catalyst used in the reaction becomes exhausted and requires immediate separation. The separated catalyst should be washed thoroughly with warm distilled water to preserve its effectiveness. To regenerate the catalyst, it must be soaked in hydrochloric acid (HCl) for 24 hours. After this step, the catalyst was completely dried before it was used again. This process was repeated five times, and the catalyst's characteristics remained almost unchanged during each use. However, the %yield will decrease with each reuse. For CS biodiesel, the %yield decreased to 89.95%, 88.20%, 80.48%, 75.60%, and 72.00% respectively for each use. Similarly, for SWCO, the %yield reduced to 94.05%, 93.54%, 90.08%, 88.76%, and 84.50% respectively for each of its five uses. The graphs provided below in (Figure 8) will give a clear visual representation of these observations.

CONCLUSION

This report aims to demonstrate the efficacy of sunflower waste cooking oil (SWCO) over castor oil (CS) to produce biodiesel via trans esterification, using CeSnMoP as a catalyst. To this end, various properties were examined for each oil type separately, followed by a comparative analysis of the resulting biodiesels. Our findings indicate that, in most cases, SWCO exhibited superior outcomes when combined with the catalyst cerium (IV) tinmolybdo phosphate [CeSnMoP], as compared to CS. Moreover, the percentage yield and calorific values of SWCO were significantly higher than those of CS biodiesel, with a ratio of Oil: alcohol::1:9 at a temperature of 80°C. Thereby validating the superiority of sunflower waste cooking oil over castor oil in terms of producing biodiesel using HPAs as a catalyst.

ACKNOWLEDGEMENT

CONFLICTOF INTEREST

The authors declare that they do not have any kind of conflict of interest during their work.

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Table 1. Observations on various properties of biodiesel produced using castor and waste cooking oil.

Sr. No.	Biodiesel	Catalyst loading (w/v)%	Density (gm/cm³)	Dynamic Viscosity (mpa.s)	Acid value (mg NaOH/g oil)	Cloud point	Pour point	Flash point	Fire point	Aniline point
						In terms of (°C)				
1	Castor oil		0.8285	0.7991	0.62	-1.0	-3.0	80.0	97.0	64.0
2.	Waste Cooking Oil	3	0.8175	0.7628	0.136	-2.5	-10.0	93.0	96.0	45.5
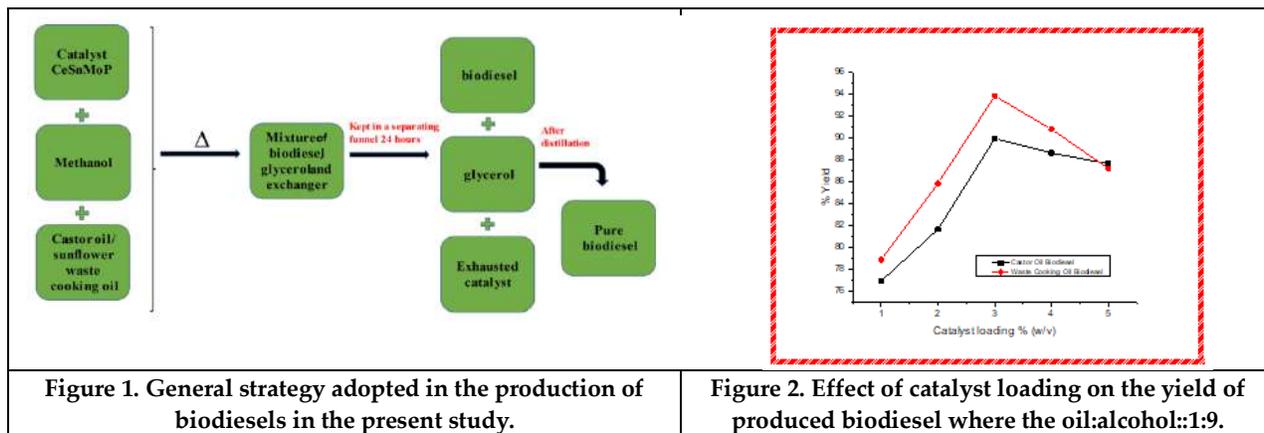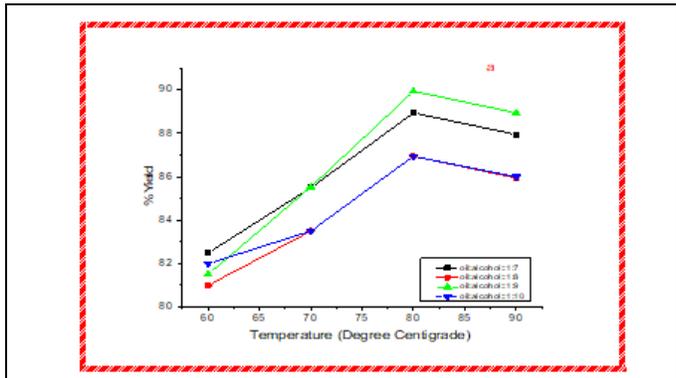
Figure 1. General strategy adopted in the production of biodiesels in the present study.	**Figure 2. Effect of catalyst loading on the yield of produced biodiesel where the oil:alcohol::1:9.**

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Figure 3: Effect of reaction temperature variation with the ratio of oil to alcohol on the % yield of resultants (a) CS biodiesel
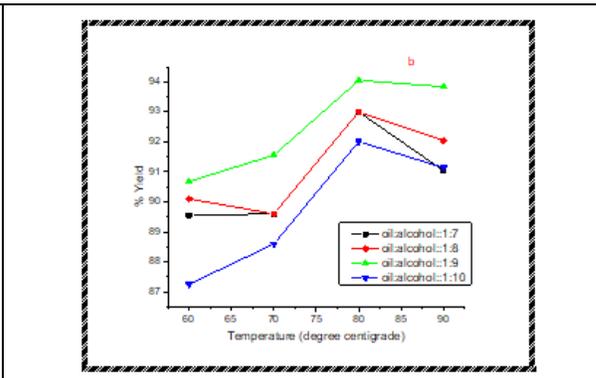
Figure 3: Effect of reaction temperature variation with the ratio of oil to alcohol on the % yield of resultants(b) SWCO biodiesel.
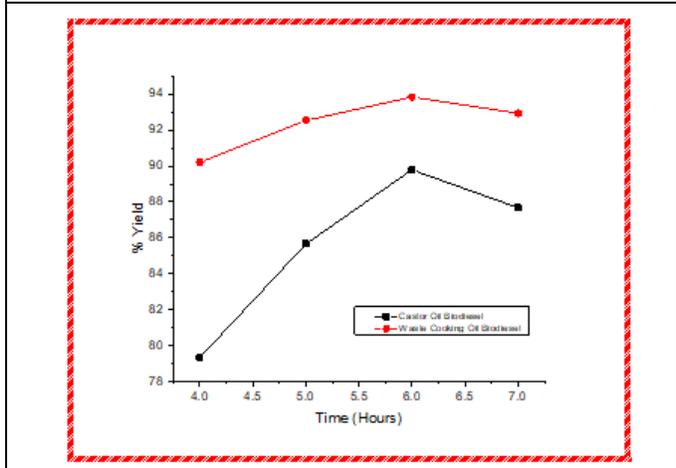
Figure 4: Effect of variation of time duration of reaction at constant catalyst loading (3%) on the yield of resultant biodiesels.
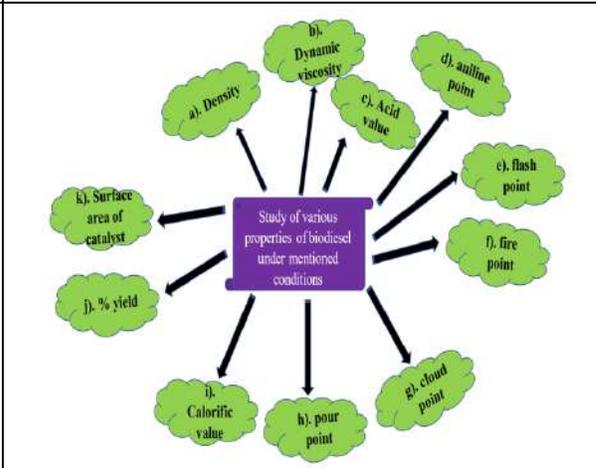
Figure 5. Properties to verify the optimization of the reaction parameters.
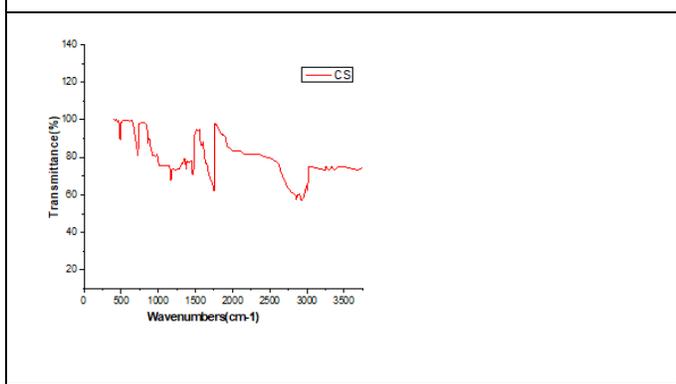
Figure 6. a)FTIR of castor oil biodiesel
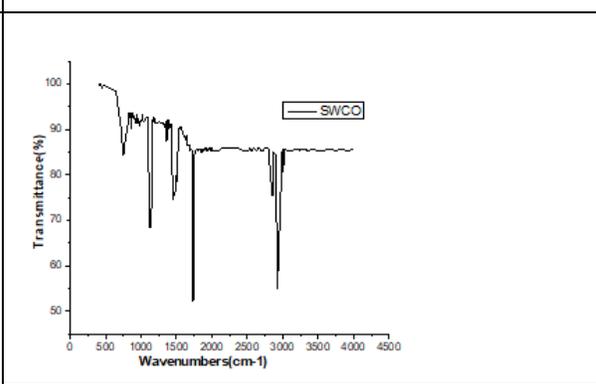
Figure 6. b)sunflower waste cooking oil biodiesel

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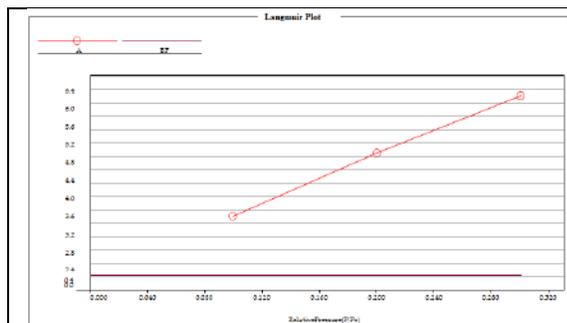
Figure 7. Langmuir plot for the BET surface area in nitrogen adsorption for the catalyst.	**Figure 8. Variation of % yield with each cycle of catalyst utilization.**
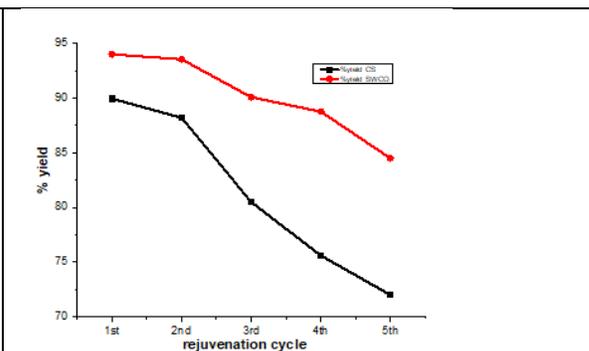
RESEARCH ARTICLE

A Strategic Framework for Environmentally Sustainable Laboratories

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ABSTRACT

The Green Chemistry approach represents a paradigm shift in the field of chemistry, emphasizing the design and implementation of processes that minimize environmental impact while maximizing efficiency. Green Chemistry, at its core, aims to mitigate pollution by creating products and processes that are intrinsically less hazardous. This entails substituting toxic substances with environmentally friendly alternatives, minimizing waste generation, and utilizing renewable resources. This abstract provides an overview of the principles and applications of Green Chemistry, highlighting its significance in mitigating the adverse effects of traditional chemical practices on human health and the environment. The adoption of Green Chemistry principles extends across diverse sectors, including pharmaceuticals, agrochemicals, materials science, and beyond. Case studies illustrating successful applications of these principles showcase the economic viability and innovation potential associated with environmentally conscious practices. In conclusion, the Green Chemistry approach offers a comprehensive and forward-looking strategy to address the environmental challenges posed by traditional laboratory practices. By embracing this framework, the scientific community can pave the way for a more sustainable and harmonious relationship between chemistry and the environment, contributing to a healthier planet for current and future generations.

Keywords: Green Chemistry, environment, hazardous, pharmaceuticals, agrochemicals etc.

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INTRODUCTION

Chemicals are essential for economic growth and human well-being, but if handled improperly, they can pose serious health concerns to people. Many chemicals end up in the environment like in water or in the air by intentional release during use, which are very catastrophic to the environment. More than seventy thousand chemicals are utilized on a daily basis all around the world, and they have an impact on our lives. They even impact the environment and the ecosystems that support human life. Such chemicals can affect human health in various ways, depending on the type, amount and duration of exposure. Chemicals released into the environment have far-reaching health consequences through pollution of air, water, and soil. This can affect ecosystems and the health of both humans and wildlife. Many chemicals are toxic to humans and can cause acute or chronic health problems. The severity of the toxicity depends on factors like the chemical's toxicity level, the route of exposure (e.g., inhalation, ingestion, dermal contact), and the dose. Exposure to specific chemicals, such as heavy metals (e.g., lead, mercury), can damage organs like the liver, kidneys, and heart. According to Chang and Lamm (2003), the impact of hazardous chemicals in laboratory on health and environment is a serious issue that requires attention and action.

Some of the hazardous chemicals found in laboratory and their effects have been given in Table1. In most laboratory and non-laboratory operations, education and research-related institutions contribute to the generation of small amounts of waste, many of which are highly toxic, and the environmental impact produced by that chemical waste is of increasing concern. Experiments are an essential component of the curriculum, and it is of utmost need to make laboratories a place with safe learning environment. Developing a sustainable framework for eco-friendly laboratory practices is a crucial and pertinent issue for both the scientific community and the general public. Laboratories play a vital role in research, analysis and education, but they also pose a considerable environmental challenge due to their intensive use of energy, water, chemicals and other resources. Hence, it is essential to embrace and apply sustainable practices that can minimize the environmental impact of laboratories, while preserving or improving the quality and safety of research. This paper presents a review of the current status and the challenges of eco-friendly laboratory practices, and suggests a comprehensive and integrated framework that encompasses four main aspects: conservation, waste minimization and resource management, hazardous waste management, and education and awareness. The framework follows the principles of green chemistry. The framework aims to offer a practical and flexible tool that can assist laboratory users to evaluate their current practices, find areas for improvement, and apply changes that can result in significant environmental and economic benefits.

OBJECTIVE OF STUDY
Due to the dangers associated with chemicals and chemical reactions, motivation to develop methodologies and formulate strategies to carry out chemical reactions in a safe and environmentally benign manner, gave birth to green chemistry which in turn is compatible with the goals of sustainable development. The objective of present study is to protect and benefit the environment using green chemistry principles by finding ways to reduce waste, conserve energy, and replace the hazardous substances through green practices in laboratories. Such practices have the potential to create a more sustainable environment capable of protecting human health.

REVIEW OF THE LITERATURE

People use chemicals in vast quantities, resulting in a large volume of chemical waste, which includes poisonous and destructive waste. They increase the quality of life when used and disposed of appropriately; nevertheless, when used and dumped poorly, they have a substantial influence on humans, plants, and animals. According to Singh et al. (1999), even micro-scale procedures, which are meant to be more ecologically friendly by minimizing the amount of chemicals used, have an inherent risk of exposure due to the nature of the chemicals being utilized. Green chemistry, which is a technique for reducing risk and avoiding pollution by addressing the inherent dangers of chemicals, is also necessary at all levels, both environmentally and economically. The American Chemical Society

(ACS) designed and endorsed a framework of 12 Principles developed by Dr. Paul Anastas and Dr.John Warner (1998) to guide chemists in thinking about how to reduce the risk that chemical interactions pose to human health and the environment. For a holistic safety culture to exist, Orgill et al. (2019) stated that a system thinking approach to incorporate green chemistry and safety into laboratory culture must be embraced at all educational stages. This is required since, if academic institutions establish a green and safety culture, then that will be carried over into subsequent career paths. As we look to the future, Zimmerman et al. (2020) emphasized that we must ensure that chemistry not only does no harm but also promotes life. Kümmerer (2017) said that the expansion of the 12 green chemistry principles to wider dimensions with the label sustainable chemistry education in university and other curricula is a more recent phenomenon. The objective of the green lab program, according to Wis singer (2018), is to inform stakeholders about the lab's environmental effects and to help them select safe, sustainable practices that they may include into their work. According to Noce (2018), chemists will be involved at the molecular level of the solutions to our global problems; as a result, they must have the education, expertise, and culture to support these goals in the safest manner possible. Methods for integrating green chemistry into laboratory practices should be researched to assist stakeholders in creating a learning environment that is free from health hazards and strong on safety.

Green Chemistry

Risk, or the probability of a harmful event, is a function of both exposure and hazard, and green chemistry plays a role in improving laboratory safety by addressing the hazard component of the function. Green chemistry's approach to reducing risk through the elimination of hazards and toxic chemicals is more effective than trying to lower exposure through the use of personal protective equipment. It can catalyse green technological innovations that result in less hazardous materials, products and processes in support of a sustainable, healthy society. Green chemistry is not only a scientific discipline, but also a philosophy and a practice that can be applied to any field of chemistry and beyond. By following the principles of green chemistry, we can create solutions that are beneficial for both people and the planet. Anastas said, "Green chemistry is powerful because it starts at molecular level andultimately delivers more environmentally benign products and processes." Through the integration of green chemistry within higher education, students can be trained to recognize and design-out molecular hazards at the earliest stage of a molecule or material lifecycle. Many green laboratory practices can be accomplished among students in the institutions to develop their proactive attitude toward environmental conservation and protection.

Principles of Green Chemistry

Green chemistry emerged from the need to find safer and more eco-friendly ways to conduct chemical reactions, as chemicals and their reactions can pose serious risks. Anatas & Warner (1998) defined green chemistry as the creation of chemical products and processes that minimize or avoid the use or production of harmful substances. To guide chemists in reducing the harm of chemical interactions to human health and the environment, the American Chemical Society (ACS) adopted a set of 12 Principles developed by Dr. Paul Anastas and Dr. John Warner and are described as under:

Prevention It is better to prevent waste than to treat or clean up waste after it has been created.
Atom Economy Synthetic methods should be designed to maximize the incorporation of all materials used in the process into the final product.

Less Hazardous Chemical Syntheses Wherever practicable, synthetic methods should be designed to use and generate substances that possess little or no toxicity to human health and the environment.

Designing Safer Chemicals Chemical products should be designed to effect their desired function while minimizing their toxicity.

Safer Solvents and Auxiliaries The use of auxiliary substances (e.g., solvents, separation agents, etc.) should be made unnecessary wherever possible and innocuous when used.

Design for Energy Efficiency Energy requirements of chemical processes should be recognized for their environmental and economic impacts and should be minimized. If possible, synthetic methods should be conducted at ambient temperature and pressure.

Use of Renewable Feed stocks A raw material or feedstock should be renewable rather than depleting whenever technically and economically practicable.

Reduce Derivatives Unnecessary derivatization (use of blocking groups, protection / deprotection, temporary modification of physical/chemical processes) should be minimized or avoided, if possible, because such steps require additional reagents and can generate waste.

Catalysis Catalytic reagents (as selective as possible) are superior to stoichiometric reagents. Example: Synthetic reagents, organo metallics and building blocks

Design for Degradation Chemical products should be designed so that at the end of their function they break down into innocuous degradation products and do not persist in the environment.

Real-time analysis for Pollution Prevention Analytical methodologies need to be further developed to allow for real-time, in-process monitoring and control prior to the formation of hazardous substances.

Inherently Safer Chemistry for Accident Prevention Substances and the form of a substance used in a chemical process should be chosen to minimize the potential for chemical accidents, including releases, explosions, and fires.

Green Laboratory Practices

Waste has a growing environmental impact since many of them are highly toxic. Education and research-related institutions also produce waste in most laboratory and non-laboratory operations, but they differ from industrial institutions in that the waste produced is smaller, more varied, and dispersed across multiple laboratories, and also, it is managed by students in different settings. Many green laboratory practices aim to reduce laboratories' environmental impact by lowering energy and water use as well as waste production. Wissinger (2018) states that the purpose of green lab program is to inform stakeholders about the lab's environmental consequences and to help them find safe, sustainable practices that they can incorporate into their work. Green Laboratories principles lead to significant reductions in the amount of energy and water used, as well as the amount of chemical and solid waste produced. Green practices at labs at all levels are also necessary from an environmental and economic perspective, as a way of addressing risk reduction and pollution prevention.

The aim of such practices is to cultivate clear awareness, attitude, commitment and skills among stakeholders to safeguard and enhance the environment. The framework for green lab practices should concentrate on three main areas: improving lab procedures to boost efficiency, choosing products that produce less waste, and conserving energy. To implement the framework in the laboratory, the strategy should begin by using a checklist or a tool to assess the lab's environmental performance in all areas of operations. Then, from analysis of assessment results, note the strengths and weaknesses. Further, based on the results, SMART goals and objectives should be set to improve the environmental performance. After that, green chemistry principles should be used to design strategies and action plans to achieve the goals and objectives. Following that, roles and responsibilities should be allocated lab staff and stakeholders to carry out your strategies and action plans. Subsequently, progress should be tracked using relevant indicators and metrics. Later, review and assessment of the outcomes and impacts should be obtained using stakeholder feedback. The three main types of green practices that can be implemented in laboratories based on the twelve principles of green chemistry are: 1. Eco-friendly Methods, 2. Waste Minimization, 3. Pollution Prevention

Eco-friendly Methods

To foster curiosity and innovation in the subject and to expose students to a variety of methods, laboratories should adopt greener experiments. Green practices should be the main focus, and traditional processes that are necessary should be modified to be more eco-friendly, if possible. Schulte et al. (2013) suggested that removing or substituting a hazard with a safer option is the best way to lower risk. Aubrecht et al. (2019) concluded that greener experiments make chemistry safer by reducing the exposure to harmful substances. To implement eco-friendly methods in the lab, some of the examples are:

1. Use safer or non-toxic alternatives that are widely available and cheap.
2. Avoid experiments that require long or high-temperature reactions.
3. Use advanced instruments, such as spectrophotometers, for analysis and measurement, and skip the conventional methods that involve many dangerous chemicals.

Waste Reduction

One of the main objectives of sustainable lab practices is to minimize the amount of hazardous chemical waste that needs to be disposed of. This can be achieved by considering the following factors in the lab:

1. All labs should use semi-micro or micro-scale methods for analysis. • Spot testing should be preferred whenever feasible.
2. Preparation of large-scale derivatives should be avoided.
3. Use TLC to check the purity of a molecule instead of using obsolete techniques.
4. Chemical reagents used in labs should be monitored and managed better.
5. Solvent recycling should be practiced.
6. Pollution Prevention

Pollution Prevention

Pollution prevention helps achieve environmental goals and also benefits in other ways, such as reducing waste, increasing efficiency, saving money, minimizing potential liabilities, and protecting against hazardous exposures. Analytical methods need to be enhanced to allow real-time, in-process monitoring and control before pollutants are formed. Some of the measures that can be taken in labs to prevent pollution are:

1. Use organic solvents that are not hazardous.
2. Recycle and save water.
3. Build green infrastructure.
4. Buy mercury-free electronic components such as switches, relays, and bulbs.
5. Select products with less harmful, bio-based ingredients that create less pollution.
6. Use fume hood in the lab to perform chemical tests releasing fumes.
7. Ensuring enough exhaust fans in the labs.
8. Pass the gases from the exhaust through alkali solution for absorption.
9. Perform dissolution of ores/alloys for preparing solution for analyses in the fume hood.

DISCUSSION AND CONCLUSION

The strategic framework for green labs can help laboratories to lower their environmental impact, save money and avoid hazards, boost their image and edge, and join the worldwide fight against environmental degradation and global warming. Key initiatives based on green chemistry principles for sustainable frame work of laboratories are outlined in Table: 2. Adopting green practices is a key way to act in harmony with life on Earth. By applying systems thinking to green practices, we can foster a culture of safety in the lab. Stakeholders are involved in finding creative solutions to our environmental issues, so they need to use systems thinking to combine green practices and safety in the lab. Niel et al. (2021) argued that effective communication and collaboration between environmental health and safety (EH&S) and sustainability experts are essential for the success of these efforts. Stakeholders need to be trained in the skills and culture that enable them to perform this task safely and efficiently. This can change the safety culture

from being compliance-based to being proactive towards environmental sustainability. The benefit of a green practice is that it helps one to care for the environment while also achieving one's goals. Green practices will help the institution's stakeholders to learn, adopt, and practice eco-friendly behaviour. The aim of the integrated green lab practice approach is to develop a comprehensive environmental awareness and sensitivity in young learners. It will also equip future caretakers of the Earth with the necessary knowledge of the whole ecosystem, both natural and social, and the skills to solve problems in a positive and sustainable way. To promote sustainability in labs, education on green practices should never stop. Stakeholders should keep learning and exchanging their ideas and knowledge, so that they can constantly improve the lab practices and make the laboratories eco-friendlier. Therefore, academic institutions should implement green lab methods for environmental sustainability, as these practices will also influence their future careers.

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Table 1: Hazardous substances in laboratories

Type of Chemicals	Effect	Examples of Chemicals
Dangerous chemicals	Harmful to the human body and environment	Acetonitrile, chloroform, formaldehyde, sodiumazide, sodium hydroxide, etc.
Oxidizers	React violently and cause fires or explosions	Nitrates, perchlorates, permanganates, chromates, peroxides, etc.
Flammable liquids	Ignite easily and burn rapidly	Methanol, ethanol, acetone, xylene, toluene, etc.

Water-reactive	Release flammable or toxic gases on exposure to moisture or water	Alkali metals, metal powders, carbides, boranes, etc.
Pyrophoric	Spontaneously ignite in air or oxygen	Metal alkyls and aryls, nonmetal alkyls, phosphorus (white), etc.
Poisons	Cause acute or chronic toxicity to the human body or the environment	Acrylamide, cyanides, sulfides, mercury compounds, etc.

Table 2: Framework for Lab practices and Action to be taken

Green Practice	Action to be Taken
Use of Safer Chemicals	▪ Choose less toxic and hazardous chemicals whenever possible. ▪ Replace hazardous substances with safer alternatives.
Chemical Inventory Management	▪ Maintain an up-to-date inventory of chemicals to prevent unnecessary purchases and waste. ▪ Properly label and store chemicals to prevent spills and accidents.
Minimize Chemical Use	▪ Use chemicals in the smallest quantities necessary to achieve the desired results. ▪ Design experiments and processes to minimize chemical consumption.
Solvent Selection	▪ Choose green solvents (e.g., water, ethanol) over hazardous or volatile organic solvents. ▪ Employ solvent recycling and recovery.
Energy Efficiency	▪ Use energy-efficient equipment in laboratory. ▪ Turn off equipment when not in use, and optimize experimental setups to reduce energy consumption.
Waste Reduction:	▪ Implement techniques such as microscale chemistry to reduce waste generation. ▪ Recycle and reuse chemicals and materials when possible.
Catalysis	▪ Employ catalytic processes to reduce the need for reagents and minimize waste.
Green Synthesis	▪ Use environmentally friendly synthesis
Green Equipment	▪ Invest in energy-efficient equipment
Education and Training	▪ Provide training for environmentally friendly techniques and technologies to stakeholders
Safety Practices	▪ Prioritize safety by following established safety protocols

RESEARCH ARTICLE

Endocrine Disorders: An Overview

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ABSTRACT

The endocrine system comprises of a vast complex arrangement of glands for the production as well as release of hormones and plays a crucial role in vital body functions, converts calories into indispensible amount of energy, which fuels the body's cells and organs. A unique different category of hormone is released into our bloodstream by each specific endocrine gland. These hormones circulate in our blood and transported to other cells where they assist in regulating and coordinating a variety of bodily functions. The complex endocrine feedback mechanism aids in the regulation of hormone levels in the bloodstream. If our body produces either high or too low of a certain particular hormone, the feedback system sends a signal to the suitable glands to address the issue. Diabetes is a carbohydrate, lipid, and protein metabolic condition that affects a considerable proportion of the world's population. Adrenal glands generate hormones that are required for regular body functioning and lack of these hormones is termed as adrenal insufficiency. Adrenal insufficiency can manifest in diverse ways, from mild nonspecific symptoms to life-threatening shock. Cushing's syndrome is a condition that happens when your body overproduces an unusual high level of the hormone cortisol for a prolonged period of time. Unless the patient is declared unfit, surgical removal of the enlarged tumor is the suggested initial line of treatment. As long as the tumor is accessible, it remains the chosen technique for recurrence.

Keywords: hormone, symptoms, bloodstream, Diabetes, cortisol, endocrine.

INTRODUCTION

The endocrine system comprises of a vast complex arrangement of glands for the production as well as release of hormones and plays a crucial role in vital body functions, converts calories into indispensible amount of energy, which fuels the body's cells and organs. Our heart rate, the overall growth of our organs, development of our bones, body tissues, coordination of body processes, metabolic rate, repair of damaged cells are all accomplished by the endocrine system. It is quite evident of developing diabetes, thyroid disease, development problems, sexual dysfunction, and a variety of other disorders linked to over or under secretion of hormones in case of endocrine dysfunction. Preventive therapy should be mostly recommended by evidence-based guidelines since patients suffering from diverse endocrine diseases usually run the risk of unfavorable outcomes brought on by their underlying endocrine pathy or secondary complications. An endocrine disorder is the consequence of the endocrine system's imperfection, which includes failure of the glands for the secretion of hormones, the receptors responding to those hormones, and lastly the organs which are directly affected. Medical conditions that can lead to dysfunction at any one of these steps can produce extensive consequences for the particular affected individual.

Glands of Endocrine System

A unique different category of hormone is released into our bloodstream by each specific endocrine gland. These hormones circulate in our blood and transported to other cells where they assist in regulating and coordinating a variety of bodily functions.

Endocrine glands include
Adrenal glands

Adrenal glands, additionally referred to as suprarenal glands, are quite small triangular in shape that are found in topmost position of both kidneys. Adrenal glands generate hormones that aid in regulating metabolic rate, immune system, development of sexual characteristics, normal blood pressure, managing stress, and other vital activities. An important glucocorticoid hormone cortisol is produced by these two adrenal glands during stress and emergency conditions.

Hypothalamus

The hypothalamus, a deep brain region that directs the release of hormones by the pituitary gland, acts as our body's sophisticated centre for control and coordinates the endocrine system. Its crucial role is to regulate heart rate, blood pressure, temperature, sleep, growth, mood, hunger thereby accomplishing a balance termed as homeostasis. Neuro hormones produced in the hypothalamus either directly alters our autonomic nervous system or may regulate the secretion of hormones from the anterior pituitary gland.

Ovaries

Ovaries are paired vital organ in the primary female reproductive system that produces ovum and sex hormones such as estrogen, relaxin, in hibin and progesterone. These are two tiny ductless oval-shaped glands lying on each side of the uterus. They develop store and release eggs and produce vital group of hormones that control our fertility, menstrual cycle and pregnancy. During ovulation one of the ovaries releases a mature egg which enables it to be fertilized by the male sperm cells.

Islet cells in the pancreas

The islets of Langer hans are pancreatic cell clusters that manufacture hormones. Islets contain four types of cells:

1. Alpha cells: Glucagon
2. The beta cells: Insulin
3. Delta cells: Somatostatin
4. PP cells: Pancreatic polypeptide

The hormones insulin and glucagon are released under the control of special islet cells confined in the pancreas.

Parathyroid

The parathyroid glands are tiny endocrine glands in the neck that regulate the body's calcium and phosphorus levels and play a major role in bone development. They are situated directly beneath the thyroid glands. Normally, there are four parathyroid glands, two beneath each thyroid gland. They are pea-sized and mediates release of parathyroid hormone (PTH) whenever calcium levels are low in the blood. PTH is a polypeptide hormone that regulates serum calcium, phosphorus and magnesium levels in the bones and blood.

Pineal gland

A tiny pea-shaped organ in the brain that can be discovered close to the brain's center and may be connected to control and monitor sleep cycles producing melatonin. It is located in the center of the brain, beneath the corpus callosum. The pineal gland's primary job is to regulate the waking and sleeping cycle. Melatonin, which governs circadian cycles, is secreted by it.

Pituitary gland

The pituitary gland termed as master gland is a pea sized gland, is located behind the sinuses near the centre at the base of the cranium below hypothalamus. It is responsible for the production of adrenocorti cotropic hormone (ACTH) and numerous other hormones such as Thyroid-stimulating (TSH), Luteinising hormone (LH), Follicle-stimulating hormone (FSH), Prolactin (PRL), Growth hormone (GH) and Melanocyte-stimulating hormone (MSH). ACTH signals the adrenal glands to produce cortisol. Because it affects numerous other glands, particularly the thyroid, it is frequently referred to as the "master gland". Pituitary gland issues can have an impact on bone development, regulates menstrual cycle, and the production of breast milk during lactation.

Testes

The testes constitute the male reproductive glands responsible for the production of sperm and testosterone. They are similar to female ovaries. The testes are mixed glands that perform both exocrine and endocrine activities. The testes are in charge of sperm production, androgen production, and testosterone secretion.

Thymus

The thymus gland is a tiny organ in the chest that is placed beneath the breastbone and between the lungs. It is essential for the development of the immune system. The primary purpose of the thymus gland is to mature T cells, often termed as T lymphocytes. These are white blood cells that aid in the fight against infections and cancer cells. The thymus gland is also involved in the production of hormones like insulin. A gland in the upper chest that aids in early immune system development.

Thyroid

The thyroid is a vital small endocrine gland in the shape of a butterfly in the lower part of the neck. The thyroid hormone aids in controlling metabolism, growth rate, and a variety of other bodily functions by comprising a self-regulatory circuit termed as hypothalamic-pituitary-thyroid axis with anterior pituitary gland, and hypothalamus. The most important hormones produced by the thyroid gland includes thyroxine or tetraiodothyronine (T4) and triiodothyronine (T3). The slightest malfunction of any of these glands can upset our body's fragile hormonal balance thereby resulting in a complicated medical condition termed as endocrine disorder or illness.

Etiology of Endocrine Disorders

The endocrine system majorly influences the development of the heart, bones and tissues, fertility, possibility of diabetes, thyroid illness, abnormalities in growth pattern, sexual dysfunction, and a number of other disorders related to hormones. Increase or decrease in levels and a total imbalance in the hormone produced by endocrine glands can be due to the following reasons:

1. The endocrine feedback system is malfunctioning
2. Disease or illness of some type
3. Disability of one gland to stimulate another gland for the release of hormones (for example, an impairment in the brain might affect pituitary hormone production)
4. A hereditary condition, such as multiple endocrine neoplasia termed as MEN or congenital hypothyroidism
5. Cases of Infection and/or inflammation
6. Injury or trauma to any particular endocrine gland
7. Tumor

Classification
Endocrine disorders are typically grouped into two categories

HORMONE IMBALANCE
The complex endocrine feedback mechanism aids in the regulation of hormone levels in the bloodstream. If our body produces either high or too low of a certain particular hormone, the feedback system sends a signal to the suitable glands to address the issue. A hormone imbalance can arise if there is a discrepancy in the feedback system in maintaining the normal quantity of hormones released into the body or if our body is not able to effectively clean them from the bloodstream. Imbalance causes endocrine illnesses when a specific gland accelerates or inhibits the production of endocrine hormone. The emergence of lesions in the form of nodules or tumors developed in the endocrine system causes endocrine illness, which may or may not alter hormone levels. A significant rise or decline in the hormones produced by endocrine glands can be the outcome of a flaw in the endocrine feedback mechanism and in some cases deficiency of one gland affects an additional gland to release hormones.

DEVELOPMENT OF LESIONS
Multiple endocrine neoplasia or MEN or congenital hypothyroidism are included in the category of hereditary disorders. The majority of endocrine tumors and nodules (tumors) are benign and they rarely spread to other parts of the body. A tumor or nodule on the endocrine gland itself, on the other hand, can interfere with the gland's capacity of hormone synthesis.

Types
There are many different types of endocrine disorders which include

Diabetes Mellitus
Diabetes is a carbohydrate, lipid, and protein metabolic condition that affects a considerable proportion of the world's population. Diabetes mellitus is a collection of metabolic disorders characterized by chronic hyperglycemia caused by abnormalities in either insulin secretion, insulin action, or in rare cases both. It is the most often diagnosed endocrine condition in the United States. Long-term glycemic management has been shown to reduce the development of various diabetic complications [1]. An increasing body of research recently supports the benefits of euglycemia in certain individuals, including critically ill cardiac surgery patients and patients with CNS or myocardial ischemia or infarction. The consequences of persistently high blood glucose levels are widely recognized, and they include atherosclerosis and neuropathy. This can prove to be fatal resulting in a extensive range of organ damage, including coronary artery disease, skin infections, and strokes, as well as micro vascular consequences such as diabetes, peripheral neuropathies, and retinopathies [1].

Adrenalin sufficiency
Adrenal glands generate hormones that are required for regular body functioning and lack of these hormones is termed as adrenal insufficiency. Adrenal insufficiency can manifest in diverse ways, from mild nonspecific symptoms to life-threatening shock. The decline in adrenal function can be overlooked until stress or sickness precipitates an adrenal crisis. The adrenal gland is divided into two distinct parts: the outer cortex and the inner medulla. Adrenal insufficiency occurs when the adrenal cortex fails to produce hormones required for proper

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physiological function. The adrenal gland produces inadequate amounts of an important hormone cortisol and aldosterone. Fatigue, weakness, stomach upset, dehydration, and skin pigmentation are some of the evident symptoms which are manifested. Adrenal insufficiency including Addison's disease is rare and occurs when adrenal glands are damaged. Pituitary hormone overproduction results in overactive adrenal glands [2].

Cushing's disease

Cushing's syndrome is a condition that happens when your body overproduces an unusual high level of the hormone cortisol for a prolonged period of time. Cortisol, basically a steroid in the glucocorticoid class is known as the "stress hormone" since it manages our body's response to stress and can suppress the immune system. Cortisol is also beneficial in keeping stable blood pressure, managing blood glucose levels, maintain cardiovascular function, minimize inflammation, and convert food into energy. This disease is a rare endocrine sickness caused by a pituitary tumor characterized by too much production of anterior pituitary adrenocorticotropic hormone (ACTH), resulting in an excess release of cortisol. Cushing's syndrome is a collection of hormonal illness that can arise in persons, particularly children, who consume high dosages of corticosteroid medicines. This is frequently caused by a pituitary adenoma or by excessive hypothalamic production of corticotropin-releasing hormone (CRH). Generalized weakness, high blood pressure, diabetes, menstruation irregularities, and psychological disorders are all symptoms of the condition. Raised cortisol levels can cause rounded moon face, fatty hump, easy bruising, depression, thin skin, acne, abdominal striae, obesity, facial plethora, and hirsutism [3].

Etiology

The most prevalent explanation of this rare syndrome is long-term, administration of cortisol-like gluco corticoids in high-dose which are meant to treat other medical conditions. Patients almost invariably have a pituitary adenoma (non-cancerous growth on pituitary gland), which is not usually visible on imaging and produce excess ACTH, thereby prompting the adrenals to over produce cortisol. Rare occurrences of widespread corticotroph cell hyperplasia may occur even without ectopic release of corticotropin-releasing hormone (CRH). The tumors are often micro adenomas (less than 10 mm in size), with only 5 to 10% being macro adenomas. Macro adenomas are more likely to occur than micro adenomas to produce excessively high concentrations of ACTH. These adenomas are caused by a number of genetic abnormalities. Ubiquitin specific peptidase 8 is the most prevalent mutation. These mutations cause aberrant growth factor expression, which, when combined with ACTH, raises cortisol levels. A tumor on the adrenal gland might cause excessive cortisol production. Adrenal tumors are usually benign, but they can be malignant.

Differential Diagnosis

Ectopic ACTH secretion, exogenous corticosteroid use, pseudo-Cushing syndrome, and physiologic hyper cortisolism are all possible diagnoses for Cushing disease [4].

Prognosis

Cushing disease is ultimately lethal if not treated. The excessive production of gluco corticoids causes mortality, which may result in a variety of medical issues, including cardiovascular problems and immune function impairment. For individuals who have surgery, gluco corticoids must be taken for the rest of their lives [4].

Treatment/Management

Depending on the etiology, treatment may involve surgery, radiation, chemotherapy and medications for lowering cortisol level. If long-term administration of glucocorticoids to treat other illness is the reason, doctor can progressively minimize your prescription that can control that disorder [3]. Glucocorticoid-treated illnesses can sometimes be treated with a non-glucocorticoid drug instead.

Gigantism and Acromegaly

A person bones and body parts may grow abnormally fast and appear peculiarly odd if the pituitary gland release sexcess quantity of growth hormone. On the contrary if growth hormone levels are quite low, he or she may stop

attaining height and may turn dwarf. Both acromegaly and gigantism are growth hormone overproduction diseases. The most prevalent cause is a pituitary adenoma secreting growth hormone (GH). Gigantism is manifested by tall stature and develops when there is hypersecretion of growth hormone before the union of the long bone epiphysis. Acromegaly develops on the contrary when there is hyper secretion after epiphysis fusion, resulting in huge extremities and a distinctive facies. A high level of insulin-like growth factor-1 (IGF-1) confirms the diagnosis of these two. Surgical excision of the tumor is the preferred first line of treatment; however, this seldom results in permanent cure, and additional treatment with somatostatin analogs or radiation is frequently required [5].

Etiology

A GH-secreting adenoma in the pituitary gland is responsible for approximately 95% of cases of acromegaly and gigantism. Acromegaly can also be caused by growth hormone-releasing hormone (GHRH) secretion from a hypothalamic adenoma or from lung or pancreas neuroendocrine tumors. Acromegaly can be caused by ectopic growth hormone release as a result of abdominal or hemopoietic malignancies. Multiple endocrine neoplasia-1 (MEN-1), neurofibromatosis, Carney complex, and McCune-Albright syndrome are multiple genetic syndromes associated with GH hyper secretion. Familial idiopathic pituitary adenomas (FIPA) caused by aryl hydrocarbon protein-interacting (AIP) mutations have been linked to acromegaly. Approximately 25% of cases of acromegaly manifest as teenagers with gigantism.

Gigantism Characteristics

Gigantism is particularly uncommon and should be examined if the patient's height reaches three standard deviations above the standard mean height or two standard deviations greater than the corrected mean parental height. Because gigantism is related to a number of diseases such as neurofibromatosis, Carney complex, and McCune Albright syndrome, it is imperative to screen for neurofibromas with cafe au lait spots, ocular gliomas, and skin lentigines.

Acromegaly Characteristics

1. Increased extremity size: Enlargement and growth of the both hands and feet is observed as a result of both bone expansion and soft tissue swelling.
2. Because of the swelling in the soft tissue, the extremities may possess"dough" like consistency which resolves with treatment; however, skeletal alterations are quite permanent.
3. Hyper hidrosis and skin tags (in approximately 98% of cases) are caused by GH-induced epithelial cell hyper proliferation.
4. Acromegalic flora: Acromegalic facial traits include a prominent supraorbital ridge, a broad nose, acne, huge lips, an overbite, prognathism, tongue enlargement, and coarsening of facial features.
5. Musculoskeletal symptoms include generalized weakness and tiredness.
6. Teeth malocclusion, joint pain in the temporomandibular region, and a distinctive inter dental separation can all result from jaw elongation.
7. Carpal tunnel syndrome affects approximately 60% of patients and is caused by median nerve enlargement as opposed to extrinsic compression.
8. Acromegaly has also been associated with kyphoscoliosis.
9. Soft tissue thickening of the upper airway and big tongue can cause deep voice and obstructive sleep apnea.

Differential Diagnosis

Acromegaly is a disorder in which patients have distinctive acromegaloid facial traits or a large stature and physique, yet laboratory tests for GH and IGF-1 are observed to be normal. In these circumstances, pituitary imaging is quite unremarkable and average. Soto's syndrome is a congenital syndrome featuring overgrowth distinguished by large build, acromegaloid facial features, intellectual and logical impairments, macrocephaly, and advancement in bone age. Further clinical characteristics include neonatal hypotonia, cardiac abnormalities, strabismus, scoliosis, and susceptibility of cancer. It is caused by chromosome 5 haploin sufficiency of the NSD1 gene. The measurement of

IGF-1 and GH levels in the laboratory is found to be normal. To distinguish it from acromegaly, detailed genetic studies are required [5].

Treatment/Management

Surgery, medicinal therapy, and radiation are the three basic treatment techniques available, all having their own pros and cons but the usage of these modalities is decided on a case-by-case basis.

Surgery

Unless the patient is declared unfit, surgical removal of the enlarged tumor is the suggested initial line of treatment. As long as the tumor is accessible, it remains the chosen technique for recurrence. The trans sphenoidal method involves entering the sphenoid sinus by a nasal or sublabial technique and thereby removing the sellar floor to access the tumor. This method can be used to remove malignancies with suprasellar extension. Endoscopic transsphenoidal resection is superior to microscopic resection in terms of tumor removal, morbidity, and sequelae. Diabetes insipidus and anterior pituitary hormone deficits are common post-surgical consequences. IGF-1 as well as levels of GH must be monitored every 12 weeks following surgery with the goal of normalizing IGF-1 and to achieve an unnoticeable GH level.

Medical Treatment

There are several medicinal medications accessible to treat growth hormone problems. They are used to treat illness that persists after surgery. Dopamine agonists like Cabergoline; Somatostatin receptor ligands including Octreotide and Pasireotide; GH receptor antagonist like pegvisomantare amongst the preferred line of treatment.

Radiation

Radiation therapy is frequently utilized as an adjuvant management for chronic disease following surgical operation; on rare occasions, it may be utilized as first-line therapy in individuals who are unable to undergo surgery. External and stereotactic single high-dose irradiation are two extensively utilized radiation therapy methods.

Hyperthyroidism

Hyperthyroidism, termed as overactive thyroid, is the condition when the thyroid gland produces excess thyroid hormones more than the body actually requires resulting in weight loss, rapid heart rate, perspiration, and anxiousness [6]. Many of our body's physiological activities accelerate at a high speed when there is high concentration of thyroid hormone. Grave's disease, an autoimmune condition, is the most widespread and prevalent outcome of an overactive thyroid gland.

Symptoms

The symptoms of hyperthyroidism can vary from individual person and may include notwithstanding increased appetite, loss in weight, heartbeat that is too fast or too irregular, nervousness, irritating behaviour, difficulty in sleeping, exhaustion shaky hands, muscular weakness, perspiration or difficulty with heat tolerance bowel movements on a regular basis, goiter, a lump or swelling in the neck area causing enlargement [6]. Hyperthyroidism is sometimes misdiagnosed in elderly as sadness or state of dementia. Older adults with hyperthyroidism may experience varied symptoms, including total loss of appetite or withdrawal from people as compared to younger adults.

Etiology

There are multiple manifestations of hyperthyroidism, including [6]:

1. **Graves' disease** Graves' disease is an autoimmune syndrome that becomes the most prevalent reason for hyperthyroidism. Due to this, the immune system attacks and weakens the thyroid gland, thereby it starts producing a disproportionate amount of thyroid hormone.
2. **Overactive thyroid nodules** These are common and usually non-malignant. However, a few or all of the nodules may become hyperactive and release excessive thyroid hormone especially common in older people.

3. **Thyroiditis** Thyroiditis refers to inflammation of the thyroid gland causing can leakage of thyroid hormone out of the gland into the bloodstream in some cases of thyroiditis. As a result, you may experience hyperthyroidism symptoms.
4. **Excessive use of thyroid hormone medication** Some hypothyroid patients may take excessive amounts of thyroid hormone medication leading the hormone levels and manifest hyperthyroidism.
5. **Noncancerous tumor** A noncancerous growth of the pituitary gland, can induce hyperthyroidism in rare situations.

Treatment/management

Treating the condition will avoid lasting health issues and at the same time can alleviate unpleasant symptoms. There is not a single separate treatment that can work for every individual. The management can be determined by the exact cause and severity of the hyperthyroidism. Medicines, radioiodine therapy, and lastly `thyroid surgery are the common treatment options.

Hypothyroidism

Hypothyroidism, or in other words underactive thyroid, is an endocrine disorder where thyroid hormone production is insufficient, resulting in fatigue, constipation, dry skin, and depression [7]. This condition is the outcome of when there is inefficiency of thyroid glands to produce enough amounts of hormones for meeting the body's needs. In youngsters, an underactive gland can cause developmental delays.

Symptoms

Many symptoms of hypothyroidism might differ from person to person. Some frequent hypothyroidism symptoms include exhaustion, unusual weight gain, difficulty in coping up with cold temperatures, joint and muscle pain, thin hair, dry skin, heavy or irregularity in menstrual periods, fertility issues and state of depression caused by decreased heart rate. Because hypothyroidism develops gradually, you may not notice symptoms for several months or even for few years [7]. A number of these symptoms, particularly weariness and particularly gain in weight, are widespread and do not always surely indicate a thyroid disease.

Etiology

1. **Hashimoto's disease** This autoimmune condition is the most common cause of hypothyroidism. The body's weakened immune system targets the thyroid gland in this condition making it inflamed and weakens its ability to produce adequate amounts of thyroid hormone.
2. **Thyroiditis** Thyroid inflammation leads to thyroid hormone stored to seep out of the thyroid gland. Primarily, this leakage elevates the concentration of these hormones in our blood, resulting in thyrotoxicosis, a medical disorder with raised abnormally high levels of thyroid hormone. Following that, thyroid gland becomes underactive, leading to a permanent condition, which requires thyroid hormone replacement.
3. **Congenital hypothyroidism** In some cases babies are born with an immature thyroid gland that is not functioning properly. Congenital hypothyroidism, if left ignored and untreated, can result in academic impairment and failure to grow at a normal pace.
4. **Surgical removal** When a portion of the thyroid gland is detached due to reasons like hyperthyroidism, goiter, tumors, etc. the remaining portion can generate standard quantities of hormones. However, some patients who undergo this operation may develop hypothyroidism. Hypothyroidism is invariably the result of removing the entire thyroid [7].

Treatment/management

Hypothyroidism is treated by supplementing hormones that our thyroid no longer produces. One can take levothyroxine, a popular thyroid hormone medication that is quite similar to the hormone produced by a healthy normal thyroid. It is typically administered in pill form, and also available in other forms such as liquid and a soft gel capsule [7]. These improved marketed formulas may assist persons with digestive issues in absorbing thyroid hormone as prescribed by their doctor.

Hypopituitarism

The pituitary gland (consisting of anterior and posterior lobes) is in charge of manufacturing and secreting hormones that play an important role in regulating endocrine function in the body. Growth hormone (GH), luteinizing hormone (LH), prolactin (PRL), thyroid-stimulating hormone (TSH), adrenocorticotropin hormone (ACTH), and follicular-stimulating hormone (FSH) are all hormones generated by the anterior lobe of the pituitary [8]. The posterior part stores and releases antidiuretic hormone (ADH) and oxytocin. Hypopituitarism is characterized as a lack of one or more of the pituitary gland's hormones. In various ways, an inadequate supply of hormones can impact how the body functions. These include, among other things, growth, blood pressure, and the ability to bear children. Women suffering from this illness may experience a cessation of menstruation cycle making the condition worse. Because of the modest presentation, hypopituitarism is associated with greater mortality due to increased cardiovascular and respiratory disorders, and early detection is critical to prevent further morbidity.

Etiology

Hypopituitarism can be caused by either a pathology of the hypothalamus inhibiting the synthesis of trophic hormones that act on the pituitary gland or a pathology of the pituitary gland itself [8].

1. Pituitary tumors are the most prevalent reason of hypopituitarism (61%). Pituitary tumors can induce an increase in one hormone, resulting in a shortage in the other pituitary hormones, as in acromegaly (excess GH with hypopituitarism from the macroadenoma). The majority of pituitary tumors are benign, and they can be secretory or non-secretory.
2. Secondary metastases from malignancies such as the breast, colon, and prostate are less prevalent. Hypopituitarism can also be caused by hypothalamic and para-pituitary malignancies such as supra sellar meningiomas, gliomas, and craniopharyngiomas.
3. Hypopituitarism can also be caused by inflammatory disorders in the pituitary gland.
4. Infiltrative disorders such as sarcoidosis, hemochromatosis, and histiocytosis may be linked to hypopituitarism.
5. Other causes include pituitary gland injury as a result of a traumatic brain injury, or iatrogenic injury through surgery or cranial irradiation [8].

Differential Diagnosis

In complex scenarios where seemingly healthy pituitary hormone levels are misconstrued in the setting of poor target organ hormone levels, a diagnosis of hypopituitarism may be missed or delayed. Adrenal insufficiency, on the other hand, should be treated based on clinical suspicion rather than waiting for laboratory evidence [8]. Following are some differential diagnoses that may be examined while making a diagnosis of hypopituitarism

Treatment/Management

The cause of hypopituitarism must be addressed. The primary goal of treatment should be to address the underlying cause of hypopituitarism. Mass lesions should be surgically removed, and associated medical issues should be treated properly. Hormone replacement therapy may be required for many people.

1. **TSH Deficit** Replacement of thyroid hormone (L-thyroxine) is essential, especially in the elderly and individuals with heart illness.TSH is no longer a valid measurement, hence peripheral hormone levels (T4 free or total) must be assessed.
2. **ACTH Deficit** To avoid an adrenal crisis, corticosteroid replacement should be started before thyroid hormone replacement. Corticosteroid dosages must be increased during times of stress, anxiety, surgical procedures, and pregnancies.
3. **Growth Hormone Deficit** GH replacement has not been well established in the treatment of adult GH deficit, unlike in children with short stature due to GH deficiency. Synthetic growth hormone replacement, such as somatotrophin, is used in children for this reason. IGF1 levels are titrated during replacement therapy. Following puberty, another examination is performed to decide if GH replacement is necessary throughout adulthood.
4. **ADH Deficit** ADH replacement with intranasal or the oral desmopressin (synthetic vasopressin) aids in the stabilization of the water balance and polyuria. Sodium levels must be kept within normal limits, and osmolality and urine specific gravity can be evaluated to ensure proper ADH replacement.

5. **FSH/LH Deficit** In men, testosterone can be administered via gel, a patch, orally, or intramuscular (IM) injections, with PSA and hemoglobin levels carefully monitored. In women, estrogen/progesterone hormone replacement treatment (HRT) can be administered orally, intramuscularly, or trans dermally.

Polycystico vary syndromeor PCOS
PCOS is a multifacetedmost prevalent condition affecting women with many clinical manifestations. It usually begins in adolescence, but symptoms might change with time. Androgen overproduction interferes with egg formation and also inhibits their liberation from the female ovaries. PCOS is one of the most common primary causes and reason for infertility. PCOS affects 8-13% of reproductive-aged women, according to estimates. Worldwide, up to 70% of affected women go misdiagnosed. PCOS is linked to a number of long-lasting health issues that can have a great impact on both physical and emotional well-being of the individual [9]. PCOS is very common and runs in most of the families, however there are ethnic differences in how it appears and affects people. It can eventually result in hormonal abnormalities, irregularity in menses, elevated testosterone levels, and cysts in the ovaries. Unstable periods, which are frequently followed by a lack of ovulation, create difficulty in pregnancy. PCOS has turned out to be a chronic disease that has actually no cure. Its symptoms, can somehow be reduced to an extent with conscious modifications in lifestyle, intake of relevant drugs, and undergoing fertility treatments. Although the etiology of PCOS is still ambiguous, women with a family history or suffering from type 2 diabetes are at a higher risk.

Etiology
PCOS is an oligogenic manifestation in which a multitude of genetic and environmental factors interact with each other to define the clinical phenotype. The exact genetic etiology is unknown and in definate, a PCOS family history is rather frequent and familial inheritance of PCOS is quite ambiguous [9]. Further a formal segregation study is not possible because of lack of phenotypic information. Nonetheless, recent research ascertains that PCOS clustering in families is quite similar in an autosomal dominant pattern. Poor dietary intake and substantial physical activity might elevate environmental factors which can aggravate PCOS in case of obesity), along with exposure to pathogenic agents and chemicals which can also play an imperative role. PCOS's reproductive and metabolic aspects are potentially treatable with lifestyle modifications that include weight loss and exercise.

Symptoms of PCOS
Symptoms of PCOS generally vary amongst individuals and can also alter unpredictably over time and frequently occur without a clear cause. Most common symptoms involve heavy, long time period, intermittent, random or irregular cycle of periods, chances of infertility, acne and greasy, oily skin, presence of excessive hair on the face or even body, male-pattern baldness or thin hair, unusual weight gain, especially confined to the belly region. Anxiety, despair, and a negative body image can all result from PCOS. Some symptoms, such as infertility, obesity, and excessive hair growth, may result in societal stigma. This can have an impact on other aspects of one's life, such as family, relationships, employment, and community activity [9].Individuals facing PCOS are likely to have the following comorbidities.

1. Hypertension
2. Type 2 diabetes
3. Heart ailments caused by excessive cholesterol
4. Endometrial cancer (cancer of the uterine lining)

Diagnosis
When making a diagnosis, clinicians consider if irregular periods and ovulation are a natural part of puberty or menopause, whether polycystic ovaries run in families, and whether women with a consistent family history of either PCOS or type 2 diabetes have more chances of developing PCOS. Furthermore, the ultrasound image can be unclear, and some PCOS women ultrasound scan may not show polycystic ovaries. PCOS shall be diagnosed by the

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presence of at least two of the following: Blood tests can detect specific variations in hormone levels, albeit these changes are not uniform. Women with PCOS may have higher levels of the following hormones [9]:

1. Testosterone, a specific androgen hormone released from the ovaries that increases hair growth
2. Oestrogen that stimulates growth of the womb lining sorrounding endometrium
3. Insulin another important hormone that is primarily responsible for energy utilization from food
4. Anti-müllerian hormone for the fertility of ovaries and
5. Luteinising hormone secreted from the pituitary hormone that can affect hormone production and is important for normal ovulation process

Management of PCOS

Although there is no cure for PCOS, medications can alleviate symptoms. People who have irregular periods, difficulty getting pregnant, or significant acne and hair growth should see a doctor without any delay in diagnosis and get a professional opinion as soon as possible. Some PCOS symptoms can be alleviated by making lifestyle adjustments. Eating a nutritious diet and doing adequate exercise can help you in losing weight considerably and lowers the chances of developing type 2 diabetes. Birth control pills (contraception) can definitely help in regulating the menstrual cycle and alleviate signs and symptoms [9]. Additional medications can help minimize acne trouble or excessive hair growth due to PCOS. Infertility caused by PCOS can be treated with lifestyle modifications, medications, or surgery to encourage regular ovulation. In-vitro fertilization (IVF) is an option, although it comes with significant hazards.

Precocious puberty

Precocious puberty of a child can be understood as the development of particular abilities or tendencies at a younger age than is typical or expected and is considered as a complex transitional period that includes growth at an accelerated rate along with development of secondary sexual characteristics. It is considered as a time of both physical and psychological growth. Numerous genetic, environmental and dietary factors play a major role in the onset, inception and progression of puberty. Early puberty happens when specific glands instruct the body for releasing sex hormones quite early in their life time. The accelerated growth rate in girls before the age of eight, and development of genital organs in boys before the age of nine, indicate precocious puberty. This type of puberty in boys poses a significant risk of underlying pathology and necessitates immediate referral to a specialist paediatric endocrinologist [10]. Several cases of early puberty in girls beyond the age of six have benign origins, but in certain situations, precocious puberty might signify significant pathology.

Etiology

Precocious puberty is classified into following two main classes on the basis of indication's etiology as follows [11]:

Management of Precocious Puberty
Central Precocious Puberty

The decision to treat cases of precocious puberty is influenced by the child's age and its rate of progression. Its recommended to consider treatment if the manifestation of child's symptoms are fast increasing or if bone age is greatly complex. The primary purpose of treatment is to maintain height of the individual appropriately and to relieve the related psychosocial stress and stigma associated with it. GnRH agonists are the time-tested gold standard of treatment. Long and short-acting GnRH agonists are available in a variety of formulations (intranasal, intramuscular, and subcutaneous). The formulation is chosen based on the preferences of the patient and the practitioner. The most common in the United States is leuprolide acetate which is a depot injection that is given every three months [10]. Recommended GnRH agonist therapy is usually regarded as secure, with no severe undesirable effects observed. Localized skin reactions such as intramuscular discomfort, sterile abscesses and post-menopausal symptoms such as hot flushes are the most common side effects. While on medication, pubertal progression, growth velocity, and skeletal maturation must be monitored on a regular basis.

Peripheral Precocious Puberty

The treatment of peripheral precocious puberty is mainly intended towards eradicating the basic source of sex steroids. In extreme cases surgery is recommended in both gonadal and adrenal tumors. If exogenous sources of these sex steroids are exactly recognized, there should be an attempt to eliminate them completely. Classic congenital CAH can be treated with specific therapy with glucocorticoids. In McCune-Albright syndrome also termed as CAH, some benefit can occurby blocking the synthesis of estrogen using aromatase inhibitors such as anastrozole, letrozole and selective receptor modulator like tamoxifen. The best possible management for familial male-limited precocious puberty is still not well recognized, but the best preferred treatment using a combination of an androgen antagonist (spironolactone) along with an aromatase inhibitor (anastrozole, testolactone) gives satisfactory results [10].

Differential Diagnosis

1. Premature Thelarche is defined as the premature unilateral or may be bilateral maturity of breast in girls aged 12 to 24 months. There are no further pubertal changes connected with this condition. Normal bone ages, growth rates, and biochemical tests can be performed. It is frequently an exclusionary diagnosis. Frequent clinical follow-up and check upis essential to assess growth, maturation and pubertal progression.
2. Premature Adrenarche is mainly characterized by the early before time synthesis of adrenal androgens. Before the age of eight years, it manifests as pubic and axillary hair, body odor, acne and many similar symptoms. Females have no breast development, and males have no testicular hypertrophy. It is critical to rule out miscellaneous androgen sources such creams or gels, adrenal tumors, and late-onset CAH.
3. Premature Menarche: Premature menarche can be understood as the development of vaginal bleeding in young girls even before seven. They can be present either with a single episode or may be a few repeated cycles which can be less than 3 and develop normally till the child reaches puberty. Current research clearly ascertains that there will be no effect observed on adult height. Cases of sexual abuse, vaginal foreign bodies, and vulva and vaginal diseases must be ruled out.

Prognosis

Early therapy usually results in better success in retaining final adult height. The outcomes are determined by variety of reasons such as the progression of bone change, the age of initiating precocious puberty, the time of beginning, and the total duration for treatment. After medication is discontinued, the hypothalamic-pituitary-gonadal (HPG) axis returns back to normal, and the children suffering from it usually develop through puberty normally. There is little known about the long-term endocrine, metabolic, reproductive, and psychological effects. Peripheral precocious puberty prognosis differs according to the etiology [11].

Herbal Approach for Treating Endocrine Disorders

Endocrine disorders like diabetes mellitus, adrenal insufficiency, cushing syndrome, growth hormone disorders, hyperthyroidism, hypothyroidism, hypopituitarism, PCOS, precocious puberty, etc. are expanding daily because of numerous contributing factors such as environmental contaminants, endocrine disrupting substances from food, and unhealthy life styles. Millions of people's lives can be severely impacted by hormonal abnormalities. Spices, herbs, medicinal plants tend to bring the disturbed hormone levels back to normal by various mechanisms. There are various factors that can affect the hormonal balance in the modern day lifestyle of a regular human being like stress reduction, herbal treatment, sound sleep, healthy food choices, physical and emotional health. The primary messengers that regulate practically every bodily system are hormones. Hormonal imbalance is a troublesome illness that has negative consequences on mind frame, metabolism, appetite, mental health and finally aging. Herbs known as adaptogenic are special medicinal plants that support immune system function, balance hormones, and lessen mental tension. There are numerous herbs that help remove toxins from the body and cleanse the liver of dangerous and hormone-disturbing substances. Hormonal problems may be treated with the aid of modern herbal infusions and essences.

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Table 1. Following is a list of medicinal plant species/ herbs used for endocrine disorders

S No	Herb	Botanical Name	Impact on Endocrine Hormones
1	Bladder Wrack	*Fucus vesiculosus*	This seaweed is an immense source of dietary iodine having the potential to alleviate thyroid gland issues resulting due to pituitary imbalances.
2	Nettle	*Urtica dioica*	It is possible to reverse iodine deficit using this powerful herb. It also enhances the activities of the thyroid and renal glands.
3	Irish Moss	*Chondrus crispus*	It is recognized for further developed creation of T3 and T4 and furthermore known as plant thyroid.
4	Ashwagandha	*WithaniaSomnifera*	White cherry or Indian ginsengis a saponin glycoside has a place with Solanaceae family. Additionally, it works on thyroid capabilities because of its enemy of oxidant properties. Guggul assists with expanding T3 creation as well as advance the change of T4 to T3.
5	Cumin seeds	*Cuminum cyminum*	The phenolic contents and flavonoids in this herb strengthen the production of insulin helping in obesity and decreasing plasma glucose levels.
6	Cinnamon	*Cinnamomum zeylanicum*	The powdered extract of this bark helps control insulin production thereby alleviating type 2 diabetes.
7	Curry leaves	*Murrayakoenigii*	These easily available leaves helps in the improvement of blood glucose levels and in recuperation of tissue injury because of diabetes.
8	Garlic	*Allium sativum*	This spice is widely known for its anti-obesity properties by keeping blood glucose in control and lowering cholesterol in body.
9	Onion	*Allium cepa*	This widely used cooking essential is a great sulphur containing herb which activates insulin delivering cells by pancreas.
10	Turmeric	*Curcuma longa*	Turmeric being a strong powder extract have solid cancer prevention agents of turmeric hostile to diabetic power by expanding insulin creation.
11	Milk Thistle	*Silybum marianum*	It is one of the best spices for liver detoxification and adjusting the additional number of chemicals created in the body. It can reduce the estrogen strength issue and furthermore accommodating in administration of progesterone in ordinary reach.
12	Black Cohosh	*Actaea racemosa*	This extract supports solid advances from menstruation to severance of monthly cycle or menopause.
13	Licorice	*Glycyrrhiza glabra*	This herb has an adaptogenic quality that directs pressure chemicals, for example, adrenaline, and that implies that it can counter adrenal weakness and energize hormonal equilibrium.

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14	Ginseng	*Panax ginseng*	Ginseng has been utilized for millennia to deal with issues such as adrenal insufficiency, weariness and absence of energy.
15	Fennel	*Nigella sativa*	Also known as kalonji. This herb is rich in antioxidants. This seed's extracts help control testosterone, insulin, thyroid hormone, and luteinizing hormone levels, among others. Nigella sativa extricate displays estrogenic movement, in basically the same manner to the chemical estrogen in our body.
16	Chasteberry	*Vitex agnus-castus*	Theses berries contain diterpenoid compounds, which might be answerable for this supplement's expected impacts on hormones like prolactin and the synapse dopamine. It's frequently synergistically used with black cohosh and showcased as a solution for side effects of menopause and backing women's regenerative wellbeing. This herb may help alleviate PCOS and precocious puberty symptoms.
17	Burdock Root	*Arctium*	One of the extremely well known and successful natural medicines for Cushing's condition because of its effect on hormonal levels. Burdock root tea can be arranged effectively and can assist with tweaking adrenal capability, subsequently disposing of a large number of the side effects of this condition.
18	Dandelion	*Taraxacum officinale*	The antioxidant compounds intensifies tracked down in dandelion, including luteolin and luteolin-7-O-glucoside, assist the liver, kidneys and adrenal organ with operating ideally, as opposed to siphoning out a lot of cortisol into the body.
19	Spinach	*Spinacia oleracea*	Spinach can counter the imbalances in electrolytes that are a typical result of Cushing's syndrome because of its high potassium, calcium, and magnesium content. It is a rich wellspring of antioxidants and has been connected to controlled hormonal levels in the body.
20	Punarnava	*Boerhaviadiffusa*	This herb is extremely accommodating in the treatment of edema, liver issues, pallor and so on, which are the fundamental side effects of hypopituitarism. Punarnava has astringent, pungent and cooling properties. It is likewise viewed as a very rejuvenative spice.
21	Gotukola	*Centella asiatica*	Gotukola spice is valuable in mind and sensory system problems as well as temperament issues in which there is a determined sensation of trouble and loss of interest. Hormonal changes in the body additionally add to gloom so gotukola is suggested in hypopituitarism patients.

Fig.1. Endocrine disorders

- Type I: β-cell destruction, mediated through either immune mediated or idiopathic
- Type II: Insulin resistance or relative insulin deficiency
- Lifestyle factors
- Genetics

Causes

- Type I: Also known as Juvenile Diabetes Mellitus *(It is Insulin Dependent Diabetes Mellitus)*
- Type II: Also known as Adult Type *(It is non-Insulin Dependent Diabetes Mellitus)*
- Gestational: associated with pregnancy
- Neonatal diabetes: affecting first 3 months of neonatal's life

Diabetes Mellitus

- Tiredness
- Thirst
- Blurred vision
- Weight loss
- Skin infections

Headaches
Hunger
Increased urination
Pain or tingling sensations

Symptoms

Fig.2 .Lack of Glucose Regulation
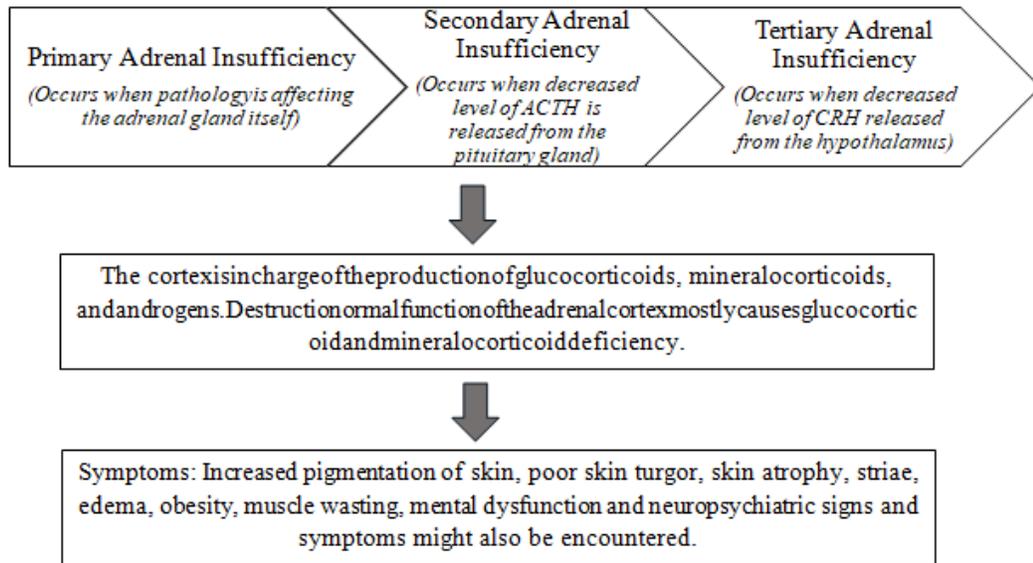
Fig. 3. Adrenal insufficiency

Fig. 4. Differential Diagnosis

High androgens - *post ruling out other possible causes of this*

Absence or irregular menstrual cycle - *post ruling out other possible causes of this*

Ultrasound scan showing polycystic ovaries

Fig. 6 .Diagnosis

Precocious Puberty

Central precocious puberty (Gonadotrophin dependent)

- Idiopathic—the most common cause of premature puberty. Both genetic and environmental variables are likely to play a role. There could be a family history of early puberty.

- CNS reasons, such as hypothalamic tumors (e.g., hamartoma or glioma), hypothalamic abnormalities, germinomas, other space-occupying lesions, congenital brain condition, acquired damage or infection

- Neurofibromatosis type 1 and Sturge-Weber syndromes, as well as tuberous sclerosis, exhibit distinct presentations and are linked to gonadotrophin dependent precocious puberty.

Peripheral precocious puberty (Gonadotrophin independent)

- Virilizing tumors include androgen-producing ovarian or adrenal malignancies, testicular Leydig cell malignancies, and human chorionic gonadotrophin-producing malignancies.

- Congenital adrenal hyperplasia—increased testosterone production may be virilizing in both males and girls.

- McCune Albright syndrome—a genetic mosaicism (ie, non-inheritable). The hormonal secretions of autonomous ovarian cysts cause gonadotrophin independent precocious puberty. Skin lesions associated with café au lait.

Fig. 7. Etiology

Fig. 8. Differential Diagnosis

RESEARCH ARTICLE

Advancements in Multispectral Pedestrian Detection: A Comparative Analysis of State-of-the-Art Techniques

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ABSTRACT

This paper investigates the field of pedestrian detection in photos or videos, which is an important component of many applications including event counting, surveillance, and fall detection for the elderly. The author explores the difficulties caused by elements such as different positions, attire, occlusion, and surroundings. The review emphasizes the significance of feature extraction and classification in the process of highlighting current pedestrian detection techniques. There is a detailed discussion of various feature types, such as gradient-based, shape-based, texture-based, motion-based, and part-based features. Wear ables, occlusion, and the variety of pedestrian poses are among the difficulties in pedestrian detection that are discussed. The two steps of pedestrian detection—feature extraction and classification—are shown in the paper's flowchart. It also discusses the applications of pedestrian detection, which include traffic safety, surveillance, and fall detection for the elderly. This paper offers insights into benchmark datasets such as the INRIA, Caltech, TUD-Brussels, Daimler-Pedestrian Detection, and ETH datasets that are frequently used to assess pedestrian detection techniques. Measures of performance evaluation are described, including Precision-Recall (PR) curves and Receiver Operating Characteristic (ROC). The paper concludes by highlighting the difficulties still facing pedestrian detection while acknowledging the progress made in the last ten years. The author makes some suggestions for possible future research paths, such as improving occlusion handling and detection accuracy for non-upright poses.

Keywords: Pedestrian Detection, Computer Vision, Feature Extraction, Benchmark Datasets, Performance Evaluation.

INTRODUCTION

One important aspect of computer vision is pedestrian detection, which is the automatic recognition and localization of people in pictures and videos. This work is extremely important for many different applications, such as public safety, autonomous cars, and surveillance(Ma & Wang, 2022). The inherent difficulties stem from the variations in the appearance, poses, occlusions, and surroundings of pedestrians. Strong detection systems are imperative because pedestrian safety is a pressing issue, especially when it comes to roads. This introduction highlights the critical role pedestrian detection plays in today's technological landscapes while offering a glimpse into the complex field of pedestrian detection. The work explores the intricacies of the assignment, covering everything from feature extraction strategies to classification algorithms, clarifying the changing field of pedestrian detection approaches(Dalal & Triggs, 2005). The study examines current datasets, performance assessment metrics, and suggests possible future paths for the field's advancement as pedestrian detection remains a research focus. Essentially, the goal of this review is to provide a thorough overview of pedestrian detection, including its methods, challenges, and broad implications for improving efficiency and safety across a range of industries. Figure 1 indicates Pedestrian and other object detection using technology.

Challenges in Pedestrian detection

Pedestrian detection in computer vision faces several intricate challenges that demand sophisticated solutions. Firstly, the diversity in pedestrian poses and appearances poses a substantial hurdle, requiring algorithms capable of recognizing individuals across a range of stances and clothing styles(Geiger et al., 2012). Occlusion, where pedestrians are partially or fully hidden from view, further complicates the task, impacting the system's ability to accurately identify individuals in obstructed scenarios. Illumination changes present another significant challenge, as varying lighting conditions can alter the appearance of pedestrians, necessitating algorithms robust enough to handle such fluctuations. Cluttered backgrounds, common in crowded urban environments, introduce complexity by requiring systems to distinguish pedestrians from a multitude of objects and surroundings(Park et al., 2018). Additionally, low-resolution images create challenges in extracting detailed features, affecting the precision of identification. Dynamic environments, marked by moving pedestrians and vehicles, demand real-time processing capabilities for timely decision-making. Adverse weather conditions, such as rain or snow, can obscure visibility, requiring pedestrian detection systems to be resilient under challenging weather scenarios. Successfully addressing these challenges is crucial for the development of robust and reliable pedestrian detection systems with broad applications in surveillance, autonomous vehicles, and public safety(L. Zhang, Paik, et al., 2019).

Why Pedestrian Detection

Road traffic accidents are a major public health concern worldwide, resulting in significant loss of life and injuries. According to the World Health Organization (WHO), an estimated 1.35 million people are killed in road traffic crashes each year, with millions more injured.

United States

In the United States, the number of road traffic fatalities has been declining in recent years. In 2020, there were an estimated 38,824 traffic fatalities in the United States, a 4.8% decrease from 2019. However, the number of fatalities increased slightly in 2021 to 39,210(L. Zhang, Liu, et al., 2019).

India

India has one of the highest rates of road traffic fatalities in the world. In 2020, there were an estimated 1,51,113 road traffic fatalities in India, a 2.7% increase from 2019. The number of fatalities has been increasing in India for several years, due to several factors, including rapid urbanization, increasing vehicle ownership, and poor road infrastructure.

China

China has made significant progress in reducing road traffic fatalities in recent years. In 2020, there were an estimated 108,829 road traffic fatalities in China, a 10.2% decrease from 2019. This decrease is due to several factors, including stricter traffic laws, improved road infrastructure, and increased public awareness of road safety(Kim & Kim, 2018).

Global Trends

The global trend in road traffic fatalities is mixed. While there has been progress in reducing fatalities in some countries, the number of fatalities continues to increase in others. The WHO has set a target of reducing road traffic fatalities by 50% by 2030. Achieving this goal will require a comprehensive approach that includes improvements in road infrastructure, vehicle safety, and driver behavior. Factors Contributing to Road Traffic Accidents There are several factors that contribute to road traffic accidents. Some of the most common causes include:

1. Speeding
2. Drunk driving
3. Distracted driving
4. Fatigue
5. Poor road infrastructure
6. Vehicle defects

Pedestrian detection plays a crucial role in addressing the alarming global trend of road traffic accidents, which claim millions of lives annually. In countries like India, with soaring fatality rates due to factors like rapid urbanization and poor road infrastructure, effective pedestrian detection becomes imperative. The technology aids in mitigating common accident contributors such as speeding, drunk driving, and distracted driving. Achieving the World Health Organization's goal of a 50% reduction in road traffic fatalities by 2030 necessitates comprehensive solutions, making pedestrian detection a pivotal component in enhancing road safety worldwide.

Research Organization

This study deftly traverses the terrain of pedestrian detection, starting with an extensive introduction that emphasizes the critical role this technology plays in a variety of applications, from autonomous vehicles to public safety. We then examine the difficulties associated with pedestrian detection, clarifying the complex obstacles caused by variables including different body positions, occlusions, and changing surroundings. The importance of efficient pedestrian detection is highlighted by presenting a global perspective on traffic accidents and fatalities. After that, a comprehensive review of the literature is presented in a comparative table that breaks down important research and their approaches. The emphasis on utilizing various imaging modalities for improved detection accuracy is crystallized in the problem definition section. A thorough comparison of the most recent methods, together with performance indicators, illuminates the developments in the field. Key findings are summarized, advancements are acknowledged, and future study directions are suggested as the work comes to a close. A smooth transition through the intricacies and advancements in multispectral pedestrian detection is guaranteed by the business.

Literature Survey

The literature is presented in the form of comparative table 1

Problem Definition

The problem addressed in the literature is the challenging task of pedestrian detection, particularly under varying and adverse conditions, such as day and nighttime scenarios. Computer vision has significantly advanced driving assistance systems, but detecting pedestrians remains a complex issue due to factors like varying lighting conditions. The literature focuses on leveraging different imaging modalities, including visible and far infrared (FIR) cameras, to enhance detection accuracy. Specifically, the research aims to assess the effectiveness of various pedestrian models (holistic, part-based, patch-based) when trained with images in the far infrared spectrum. The combination of visible and non-visible imaging modalities, especially with the critical role played by the infrared spectrum, is explored.

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Additionally, the study delves into the use of deep convolutional neural networks (CNNs) to exploit multispectral information for robust pedestrian detection in both daytime and nighttime scenarios. Challenges such as insufficient illumination, small-sized pedestrian instances, and occlusion are addressed through innovative methodologies, including pixel-level image fusion, novel fusion architectures, and attention mechanisms. The overarching problem definition involves developing advanced pedestrian detection systems that can operate seamlessly in diverse environmental conditions, thereby enhancing safety in applications like advanced driver-assistance systems, autonomous vehicles, and video surveillance. The research contributes novel approaches, frameworks, and architectures to overcome the inherent challenges in pedestrian detection, providing valuable insights for the development of more reliable and effective computer vision systems.

Techniques Comparison in terms of Metrics

Many novel techniques have been investigated in the field of pedestrian detection to improve resilience and accuracy, particularly in difficult situations like changing lighting and multispectral scenarios. The "Pedestrian Detection (Visible and FIR)" study employs a novel evaluation method by utilizing the Far Infrared (FIR) spectrum to assess pedestrian models. This approach, which makes use of both visible and non-visible imaging modalities, achieves a remarkable 95% day/night detection accuracy(González et al., 2016). In "Thermal-Visible Video Fusing," the fusion of color and thermal data presents a fusion-tracker and classifier. With a 96 percent accuracy rate, the method shows strong performance and can handle a variety of scenarios, even when the dataset utilized is not stated explicitly. Using pixel-level fusion on the KAIST multispectral dataset, the "Multispectral Pedestrian Detection (CNNs)" study explores the use of Convolutional Neural Networks (CNNs) for pedestrian detection. The 2.43 percent reported log-average miss rate highlights how well this method works to provide precise identification in a range of spectral channels(Ding et al., 2020a). Another study uses illumination-aware deep neural networks to investigate "Fusion of Multispectral Data (Illumination)".

This technique achieves an outstanding 94 percent accuracy on the KAIST dataset by integrating illumination information into the learning process, highlighting the significance of lighting conditions in multispectral pedestrian recognition(Z. Cao et al., 2021). With a 95% accuracy rate, "Box-Level Segmentation (Real-time Identification)" uses a unique box-level segmentation technique for real-time multispectral pedestrian detection on the KAIST dataset(Y. Cao et al., 2019). This approach improves computational efficiency and solves problems related to hyper parameter settings, which makes it appropriate for uses in autonomous driving, among other applications. The last study is "Attention Fusion (One-Stage Detection)," which presents a multispectral channel fusion one-stage YOLOv4 technique(L. Zhang, Liu, et al., 2019). This approach demonstrates its efficacy in multispectral pedestrian detection with competitive log-average miss rates of 2.43 percent for color and 3.42 percent for thermal channels when tested on the KAIST and Utokyo benchmarks. In brief, by utilizing cutting-edge methods like multispectral fusion, deep learning, and segmentation to improve accuracy and robustness under varied datasets and situations, these works jointly boost pedestrian detection systems. The overall result description is given in table 2

Approaches for Pedestrian detection

CNN

Convolutional Neural Networks (CNNs) have revolutionized computer vision tasks, and one of their notable applications is pedestrian detection. Pedestrian detection involves identifying and locating individuals within an image or video frame, a crucial task in various domains like autonomous vehicles, surveillance, and robotics. Let's delve into the architecture and workings of a CNN tailored for pedestrian detection, emphasizing its key components and their roles in achieving accurate and robust results. The input layer in a Convolutional Neural Network (CNN) serves as the gateway for information from the raw image data into the neural network. In the context of pedestrian detection, the input layer plays a pivotal role in transforming the visual information captured by an image into a format that the network can comprehend and analyze(Saeidi & Ahmadi, 2018). Consider an image as a grid of pixels, where each pixel represents a tiny unit of information. In the input layer, these pixels act as individual nodes, forming the foundation of the neural network. Each node corresponds to the intensity or color value of the respective pixel, encapsulating the visual features of the image.

The power of the input layer lies in its ability to retain spatial relationships within the image. Unlike traditional neural networks that treat input as a flattened vector, CNNs maintain the 2D structure of the image. This preservation of spatial information is vital for tasks like pedestrian detection, where the relative arrangement of pixels carries essential cues for recognizing human figures within the scene. Furthermore, the input layer is not limited to a single channel in the case of colored images. It accommodates multiple channels corresponding to different color channels (such as red, green, and blue). This multichannel representation enriches the network's ability to discern intricate details and color variations, enhancing its capacity to identify pedestrians amidst diverse visual backgrounds(Ding et al., 2020b). As the initial layer in the CNN architecture, the input layer serves as a canvas upon which subsequent layers will extract hierarchical features. Through convolutional operations, the network can capture local patterns and textures, gradually piecing together a complex representation of the input image. The input layer, thus, acts as the fundamental interface where the neural network begins its journey to understand and interpret the visual world, with each pixel contributing a unique piece to the puzzle of pedestrian detection. The first layer of the Convolutional Neural Network (CNN) is a Conv2D layer, a fundamental component for image feature extraction. This layer is characterized by 32 filters, each a 3x3 matrix, applied to input images with dimensions 64x64 pixels and 3 color channels (RGB). These filters, serving as learnable weights, convolve across the input image, systematically capturing spatial patterns and features. The activation function used is Rectified Linear Unit (ReLU), a non-linear operation that introduces non-linearity to the network. ReLU replaces all negative pixel values with zero, enabling the model to learn intricate representations and complex relationships within the data. By applying 32 such filters, the layer generates feature maps that highlight relevant patterns, edges, and textures, contributing to the hierarchical learning process of the entire CNN(P. Zhang & Wang, 2017). The choice of 32 filters allows the network to learn diverse features in parallel, providing a richer representation of the input. As the initial convolutional layer, it plays a crucial role in extracting low-level features, paving the way for subsequent layers to capture more abstract and high-level representations as the data progresses through the network. The ROC curve corresponding to CNN is given in figure 2

VGG16

The VGG16 model, which stands for the Visual Geometry Group 16-layer model, is a deep convolutional neural network architecture made to sort images into different groups. VGG16 was first made for general image recognition tasks, but it has since been used in other areas of computer vision, such as finding people walking on the street. Knowing how it works and what it can do will help you figure out how to use it effectively for these kinds of tasks.

The architecture of VGG16 is simple and uniform, which makes it stand out. There are 16 layers in it, mostly convolutional layers, max-pooling layers, and three fully connected layers. It is famous for having a deep stack of 3x3 convolutional filters, which is an important part of the VGG architecture(Yoshikawa &Premachandra, 2022). The architecture starts with a stack of convolutional layers, and then there is an activation function called a rectified linear unit (ReLU) for each layer. These convolutional layers are very important for picking up small details and patterns in the input image. VGG16 uses many convolutional layers, and each one has a small receptive field (3x3). By stacking these layers, the network can learn more complex representations.

Max-pooling layers come after the convolutional layers. They reduce the number of spatial dimensions and add a type of translation invariance. Additionally, this step helps the network keep its ability to spot patterns no matter where they are in the image. As you go deeper into VGG16, you can learn more abstract and high-level features. The network gets smarter about these features as it goes deeper into the hierarchy of representations. Finally, there are fully connected layers at the top that sort the learned features into groups (Bell et al., 2016). Through transfer learning, VGG16 can be used to find pedestrians. The VGG16 model, which has already been trained on big image datasets like Image Net, pulls out features. Once VGG16's convolutional layers have learned a lot of hierarchical features, they can be fine-tuned on a smaller dataset that has been labelled specifically for detecting pedestrians. Fine-tuning means making changes to the last few layers of the VGG16 model that has already been trained so that it can do the pedestrian detection task. The output layer is changed to show whether the object is a pedestrian or not, and the model is trained on a dataset that only contains pedestrians(Dai et al., 2016).

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VGG16's strength is that it can capture detailed spatial information by using small convolutional filters. This makes it good for tasks where complex patterns are important, like finding people on the street. Even though VGG16 might not use as few resources as more modern architectures like ResNet or Efficient Net, it is still a good choice when resources are available because it is easy to use and good at learning features. The architecture of the VGG16 model that was used is shown in Table 6. In conclusion, the VGG16 model, with its deep convolutional architecture and hierarchical feature learning, can be effectively used for pedestrian detection through transfer learning. Its adaptability and ability to capture complex spatial patterns make it a reliable choice for various computer vision applications, including the detection of pedestrians in images. A Convolutional Neural Network (CNN) is said to be 90% accurate at finding pedestrians, while the VGG16 model is considerably more accurate at 95%. This means that the VGG16 model is better than the standard CNN at correctly identifying people walking in pictures.

The reported accuracy values show how well the models correctly labelled situations as either pedestrians or non-pedestrians. If there is a 5% difference in accuracy, it means that the VGG16 model is much better than the CNN. The VGG16 architecture, which is known for its many convolutional layers and hierarchical feature learning, shows that it can effectively capture complex patterns and representations that are useful for detecting pedestrians. This isn't true for the CNN, which may have a simpler architecture but still gets 90% accuracy, which is better than the VGG16 which is more complex. These accuracy metrics are important for testing how well the models work in real-life situations where finding pedestrians accurately and reliably is important for safety and security, like in self-driving cars or surveillance systems. Because the VGG16 model is more accurate, it might be good for situations where a high level of accuracy is needed when identifying pedestrians.

CONCLUSION

Finally, this work explores the challenging field of pedestrian detection in images and videos, tackling issues caused by different lighting, stance, and occlusion scenarios. The extensive review of the literature delves into several techniques for extracting features and classification algorithms that are essential for reliable pedestrian identification. The comparative study of cutting-edge methods, which is shown in Table 2, emphasizes the importance of multispectral fusion, deep learning, and segmentation techniques by showcasing their distinct strategies and outstanding results. The results demonstrate the progress made in pedestrian detection, including noteworthy successes like a 95% accuracy rate for day/night detection in the "Pedestrian Detection (Visible and FIR)" study and a strong 96% accuracy rate in the "Thermal-Visible Video Fusion" study. The "Multispectral Pedestrian Detection (CNNs)" study demonstrates the effectiveness of CNNs and pixel-level fusion with a low log-average miss rate of 2.43 percent. "Fusion of Multispectral Data (Illumination)" uses illumination-aware deep neural networks to achieve an astounding 94 percent accuracy. The "Box-Level Segmentation (Real-time Detection)" study addresses the real-time applicability of pedestrian detection, improving computational efficiency and reaching 95% accuracy. Finally, a competitive one-stage YOLOv4 technique with log-average miss rates of 2.43 percent for color channels and 3.42 percent for thermal channels is shown in the "Attention Fusion (One-Stage Detection)" study. These developments have a substantial impact on a wider range of applications, including event counting, safety, and surveillance—particularly about traffic accidents. The paper's conclusion acknowledges both the issues that still exist and the progress that has been accomplished over the past ten years. To facilitate the ongoing advancement of pedestrian recognition technologies, it makes recommendations for future research topics, such as enhancing occlusion handling and detection accuracy for non-upright stances.

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Table 1: Number of deaths in different countries due to accidents

Country	2020	2021
United States	38824	39210
India	151113	155026
China	108829	98924

Table 2: Comparative table of literature

Article Title	Authors	Journal/Conference	Year	Methodology/Approach	Key Findings
Pedestrian detection at day/night time with visible and FIR cameras: A comparison(González et al., 2016)	González AF, Fang Z, Socarras Y, et al.	Sensors (Switzerland), 16(6)	2016	Assessment of pedestrian models (holistic, part-based, patch-based) using far infrared spectrum in day/night conditions.	Visible and FIR camera fusion improves detection accuracy. Infrared spectrum plays a critical role, and early fusion enhances results.
Thermal-visible video fusion for moving target tracking and pedestrian classification(Leykin et al., 2007)	Leykin A, Ran Y, Hammoud R	IEEE Computer Society Conference on Computer Vision and Pattern Recognition, 2007	2007	Fusion-tracker and pedestrian classifier for color and thermal cameras.	Background model construction with particle filter. Pedestrian classification based on periodic gait analysis. Robust to illumination noise in outdoor environments.
Multispectral pedestrian detection based on deep convolutional neural networks(Hou et al., 2018)	Hou Y, Song Y, Hao X, et al.	Infrared Physics and Technology, 69-77, 94	2018	CNN-based multispectral pedestrian detection. Pixel-level image fusion evaluation.	Thermal images enhance nighttime detection. Pixel-level fusion methods show comparable or

					better performance than CNN-fusion architectures.
Fusion of multispectral data through illumination-aware deep neural networks for pedestrian detection(Guan et al., 2019)	Guan D, Cao Y, Yang J, et al.	Information Fusion, 148-157, 50	2019	Illumination-aware weighting mechanism in deep CNNs for multispectral pedestrian detection.	Incorporating illumination information significantly boosts detection performance. Effective framework for multispectral pedestrian detection.
Box-level segmentation supervised deep neural networks for accurate and real-time multispectral pedestrian detection(Y. Cao et al., 2019)	Cao Y, Guan D, Wu Y, et al.	ISPRS Journal of Photogrammetry and Remote Sensing, 70-79, 150	2019	Box-level segmentation supervised learning for multispectral pedestrian detection using visible and infrared channels.	Overcomes hyperparameter setting issues, provides accurate detection for small and occluded pedestrians. Improves computational efficiency for real-time applications.
A mobile vision system for robust multi-person tracking(Ess et al., 2008)	Ess A, Leibe B, Schindler K, et al.	26th IEEE Conference on Computer Vision and Pattern Recognition, CVPR, 2008	2008	Mobile vision system for multi-person tracking integrating visual odometry, pedestrian detection, depth estimation, and tracking.	Integration of vision modules enhances tracking performance in busy environments. Feedback loops and automatic failure detection for stability.
Convolutional neural networks for multispectral pedestrian detection(Ding et al., 2020a)	Ding L, Wang Y, Laganière R, et al.	Signal Processing: Image Communication, 82	2020	Pedestrian detection leveraging multispectral images (color and thermal) with deep CNNs.	Multispectral images overcome limitations in challenging conditions. Proposed method outperforms baseline and other architectures on

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					the KAIST benchmark.
A novel MEMS gyro north finder design based on the rotation modulation technique(Y. Zhang et al., 2017)	Zhang Y, Zhou B, Song M, et al.	Sensors (Switzerland), 17(5)	2017	MEMS gyro north finder based on rotation modulation technique with wireless power and data transmission.	Single gyro and single accelerometer north finding scheme. Reduction in cost, volume, and introduction of wireless technology. Excellent potential for various applications.
Multispectral interaction convolutional neural network for pedestrian detection(Ryu et al., 2022)	Ryu J, Kim J, Kim H, et al.	Computer Vision and Image Understanding, 103554, 223	2022	Multispectral Interaction Convolutional Neural Network (MICNN) for fusing information between multispectral networks.	MICNN improves fusion of color and thermal streams. Halfway Fusion architecture yields best performance on KAIST and Utokyo pedestrian benchmarks.
Attention fusion for one-stage multispectral pedestrian detection(Z. Cao et al., 2021)	Cao Z, Yang H, Zhao J, et al.	Sensors, 21(12)	2021	One-stage YOLOv4 for multispectral pedestrian detection with novel Multispectral Channel Feature Fusion (MCFF) module.	MCFF enhances feature fusion, and Halfway Fusion architecture achieves the best performance. Adaptation of fused features in color and thermal modalities.

Table 3: Metric Comparisons for the techniques use for Pedestrian detection.

Study	Approach	Dataset	Performance
Pedestrian Detection (Visible and FIR)	Evaluate pedestrian models using FIR spectrum	New dataset & KAIST multispectral dataset	Day/Night detection accuracy: 95%
Thermal-Visible Video Fusion	Fusion-tracker and classifier for color and thermal	Not specified	Robust performance: accuracy: 96%
Multispectral Pedestrian Detection (CNNs)	CNNs-based detection with pixel-level fusion	KAIST multispectral dataset	Log-average miss rate: 2.43%

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Fusion of Multispectral Data (Illumination)	Illumination-aware deep neural networks	Multispectral images with illumination information	Performance on KAIST dataset: Accuracy: 94%
Box-Level Segmentation (Real-time Detection)	Box-level segmentation for multispectral detection	KAIST multispectral dataset	Performance on KAIST dataset: Accuracy: 95%
Attention Fusion (One-Stage Detection)	One-stage YOLOv4 with multispectral channel fusion	KAIST and Utokyo pedestrian benchmarks	Log-average miss rates: Color –2.43%, Thermal – 3.42%

Table 4: Representation of image at input layer in perms of pixel

251	55	89
52	45	25
-	-	-
87	85	25

Table 5: Convd layer

Layer Type	Number of Filters	Filter/Kernel Size	Activation Function	Input Shape	Description
Conv2D	32	(3, 3)	ReLU	(64, 64, 3)	Applies 32 convolutional filters of size 3x3 to the input image. The ReLU activation function introduces non-linearity, enabling the network to learn complex features. The input images are of size 64x64 pixels with 3 color channels (RGB). This layer serves as a crucial feature extractor, capturing spatial patterns and forming the foundation for hierarchical feature learning.

Table 6: Architecture of VGG16

Layer Type	Output Shape	# of Parameters
Input Image	(224, 224, 3)	0
Conv1-1 (3x3)	(224, 224, 64)	1792 (3x3x3x64)
Conv1-2 (3x3)	(224, 224, 64)	36928
MaxPooling	(112, 112, 64)	0
Conv2-1 (3x3)	(112, 112, 128)	73856
Conv2-2 (3x3)	(112, 112, 128)	147584
MaxPooling	(56, 56, 128)	0
Conv3-1 (3x3)	(56, 56, 256)	295168
Conv3-2 (3x3)	(56, 56, 256)	590080
Conv3-3 (3x3)	(56, 56, 256)	590080
MaxPooling	(28, 28, 256)	0
Conv4-1 (3x3)	(28, 28, 512)	1180160
Conv4-2 (3x3)	(28, 28, 512)	2359808
Conv4-3 (3x3)	(28, 28, 512)	2359808
MaxPooling	(14, 14, 512)	0
Conv5-1 (3x3)	(14, 14, 512)	2359808
Conv5-2 (3x3)	(14, 14, 512)	2359808
Conv5-3 (3x3)	(14, 14, 512)	2359808

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MaxPooling	(7, 7, 512)	0
Flatten	25088	0
Fully Connected	4096	102764544
Fully Connected	4096	16781312
Fully Connected	1000 (Output)	4097000
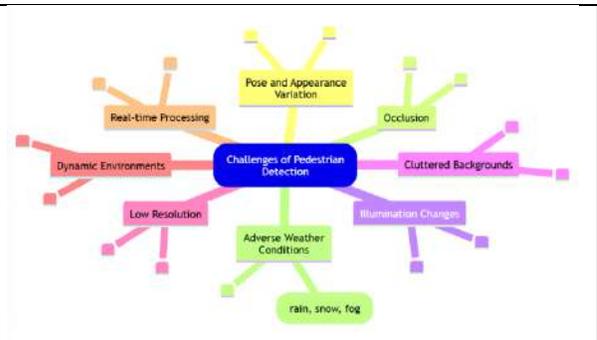
Figure 1: Pedestrian and other object Detection

Figure 2: Challenges of pedestrian detection
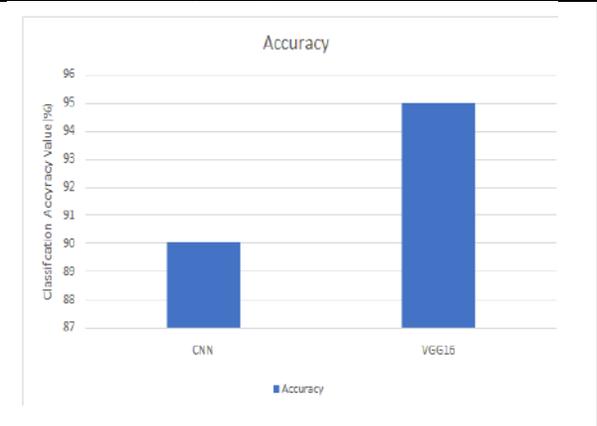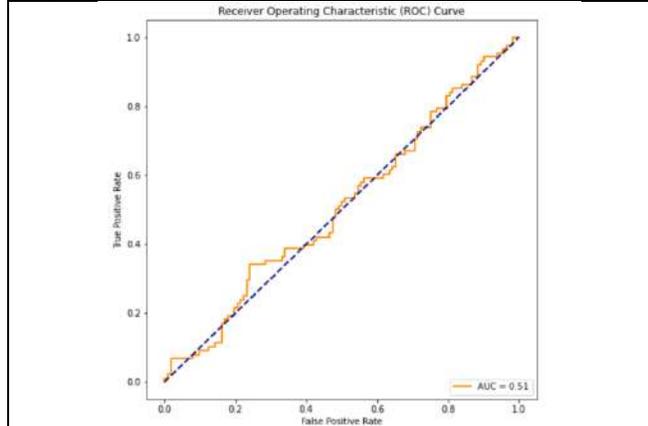
Figure 3: ROC curve corresponding to Pedestrian detection with CNN

Figure 4: Accuracy of Models in pedestrian prediction

RESEARCH ARTICLE

Agricultural Waste Management Strategies using 3 "R" Approach

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ABSTRACT

Agricultural wastes are byproducts of the production and processing of agricultural products. Many sources, such as crop residues, agro-industries, livestock and aquaculture contribute to the generation of agricultural wastes. To meet the growing demands of the rapidly expanding population, an abundance of agricultural wastes are produced daily throughout the world. They may contain useful materials, but their economic worth is less than the expenses associated with gathering, transporting and preparing them for human use. Efficient and timely disposal is essential for the proper use of organic materials in agricultural waste and for reducing the impact of pollution to the environment. The rate at which organic fertilizer is given to the soil must be improved gradually in order to reduce the usage of chemical fertilizers. Agricultural wastes account for a significant portion of the world's overall waste production in wealthy economies. The uncontrolled use of chemicals in agriculture and the unreasonable application of intensive farming techniques often result in wastes that accompany agricultural development, which has a significant impact on both the global environment and rural ecosystems in particular. According to the "3R" waste management approach, these wastes are used for a variety of purposes that includes different agricultural waste management solutions based on the circular bio-economy, which increase sustainable agriculture and reduce environmental pollution by "reducing," "reusing" and "recycling" agricultural wastes.

Keywords: waste management, recycle, reduce, reuse, agriculture, environment

INTRODUCTION

Modern agriculture differs greatly from our traditional methods in that it uses technology, fertilizers, pesticides, fungicides, raw food processing, transportation, preservation, and consumption (Tubiello*et al.*, 2015;Baker *et al.*, 2017; Amorim 2023). Although modern farming technology has made a substantial contribution to a boom in the world's

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food supply, agriculture has also been an important contributor of waste and pollution(Atinkut*et al.*, 2020; Hsu 2021, Yang *et al.*, 2022).These operations produce numerous, varied waste streams, both bio-degradable and non-biodegradable, which have a substantial negative influence on the environment(Hurni *et al.*, 2015).The term "agro-waste" encompasses all residues, both bio-degradable and non-biodegradable, produced at the farm level during the vegetable production, processing, storage, and marketing processes (Pardo *et al.*, 2017; Dai *et al.*., 2018).It also refers to unnecessary waste produced by farming operations, including plastic, crop leftovers, garbage, packaging materials or cartons, containers for pesticides and fertilizers, weeds, leaf litter, sawdust, etc. (Baker *et al.*., 2017).

Reduced water holding capacity, changed soil biological metabolisms, unbalanced nutrient cycles, uneven organic matter distribution, and the production of greenhouse gases like N_2O, SO_2, CH_4, and smoke are a few of the environmental issues that can result from improper waste management and disposal (Josimovic*et al.*, 2015; Steinmetz *et al.*, 2016; Pardo *et al.*, 2017 and Dai *et al.*, 2018).As per Oyedotun*et al.*(2021), emissions of greenhouse gases cause climate change, which has detrimental effects on the environment, the economy, and human health. He *et al.* (2019) found that burning farm waste is a typical practice in developing nations that contributes significantly to air pollution.It was observed by Atinkut*et al.* (2020) that burning of crop residue has a variety of negative effects on farms, such as decreased soil organic matter and nutrients, decreased production and productivity, worse air quality, reduced biodiversity, reduced water and energy efficiency, and negative health effects on people and animals. Samiha (2013)and Anwarul and Jahiruddin(2015) found that polythene is a material that farmers use to irrigate crops, store and sell their harvested goods, preserve soil moisture, and shield their crops from intense heat and precipitation. Sarangi *et al.* (2023) concluded that there is an urgent need for long-term solutions to the dire state of agro-waste management, since it poses a major risk to human health as well as the environment.

The concept of the 3Rs approach
Reducing, reusing, and recycling are commonly referred to as the "3Rs," primarily in relation to production and consumption. It advocates for a higher proportion of recyclable materials, more recycling of production waste and raw materials, and a general decrease in the amount of energy and resources required(Balls,2009).As per observations of Atinkut*et al.*, 2020; Das *et al.*, 2019 and Abadi *et al.*, 2021, sustainable agro-waste management based on the reduce, reuse, and recycle (3Rs) principles is difficult to execute in many developing countries due to farmers' lack of sustainable waste management behaviour. Any waste management strategy's real implementation, meanwhile, is contingent upon people's capacities. Numerous nations have implemented initiatives and programs to involve farmers in environmental management tasks, acknowledging the significance of perception and capability (Atinkut*et al.*., 2020; Mills *et al.*, 2017).He *et al.*, (2019) found that several waste management techniques have arisen and are being supported globally, including fertilization, energy utilization, matrix utilization, materialization, fodder use, and complete waste utilization. Agricultural waste management has been the focus of circular economy and bio-economy frameworks in recent times(Duque-Acevedo *et al.*., 2020).The decision to engage in the management of 3Rs based (reduce, reuse, and recycle) agro-waste is taken by individual farmers based on their perceptions and current capacity. Additionally, as per Abadi *et al.*,(2021) it is argued that sustainable behavioural changes can effectively address global environmental issues. Since it will decide whether any suggested strategy is successful, it is vital to comprehend how individual farmers perceive and are able to effectively manage agro-waste(Abadi *et al.*., 2021; Ananno*et al.*, 2021). Balwan *et al.*, (2022) noted that by consistently using this methodology to waste reduction and recycling initiatives, landfill waste will be minimized, which is an important approach in lowering emissions of greenhouse gases. The following brief discussion of the 3Rs hierarchy of waste management represents an upstream approach for minimizing waste's negative effects on the environment and economy while conserving resources.

(i) **Reduce** Simply means to avoid waste since preventing waste from being created in the first place is the most effective strategy for avoiding it. Reduce in the 3Rs also refers to using less, either by using resources more effectively or by using them in the first place (Fahzy, 2014). This can involve actions like putting off lights while leaving a room, restoring rather than replacing products, and using reusable shopping bags instead of disposable ones. Initiatives for waste source reduction, such as avoidance, reduction, and reuse, seek to cut

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waste at its source by altering manufacturing and consumption patterns or redesigning products. (Adedipe*et al.,* 2005).

(ii) **Reuse** As per Arenibafo (2023), Reuse is any method of operation whereby components or objects that are not waste are put to new uses for the original purposes for which they were initially intended and built. In waste management, the term "reuse" can also refer to recovery efforts, which involve inspecting, cleaning, or repairing waste items or parts so they can be used again without requiring additional preparation.Adedipe*et al.,* (2005) noted that Reuse centres have been built in many nations. These facilities aim to break the short product-towaste cycle by fixing the items and selling them for a fair price. The reuse centres provide employment assistance to individuals who are having difficulty breaking into the workforce or who have been unemployed for an extended period of time. In Japan and other developed countries, company clusters have emerged where the deemed waste of one industry is the valuable resource of another.

(iii) **Recycle** Most industrialized nations define "recycling" as the widespread collecting and reuse of common waste products, including empty beverage containers (Arenibafo, 2023). Collection, Sorting, Cleaning, Crushing or Grinding, Melting and Forming, and Reprocessing into a New Product are the typical steps in the recycling process. Hoornweg*et al.* (2012) states that Recycling and recovery have two main benefits: they minimize the amount of garbage that is disposed of and bring materials back into the economy. Recycling can only be done on substances or things that are selected as waste. To recover a large percentage of thrown objects, individual waste pickers in many developing countries engage in informal waste sorting and collection at municipal collection stations and disposal sites. Without a doubt, recycling boosts the economy, adds jobs, and preserves the environment. Christy *et al.,* (2014) and Li *et al.,* (2014) concluded that anaerobic digestion is known as the degradation of organic compounds to simple substances by microorganisms which live as syntrophy under the lack of oxygen with releasing biogas.The treatment of animal manure and slurries by anaerobic digestion process has the beneficial outcomes of producing quality fertilizer, reduction of odors and microbial pathogens with the sustainable production of energy source as biogas (Nasir *et al..*, 2013; Ch'ng *et al..*, 2013). Anaerobic digestion has been found as a biological process for the transformation of waste materials to energy sources through the treatment of various organic waste such as municipal solid waste, food waste, industrial waste, sewage sludge, animal manure and agricultural residues (Yong *et al..*, 2015; Celik and Demirer, 2015; Huang *et al..*, 2015; Nitsos*et al..*, 2015 and Shen *et al..*, 2015). Furthermore, Nasir *et al.,* (2013) and Ounnar*et al.,* (2012) found that the treated organic waste (digestate) is used as an organic fertilizer for arable land instead of mineral fertilizer as well as an organic substrate for green house cultivation.

CONCLUSION AND RECOMMENDATION

The issue of waste management in developing nations is made worse by the following factors: a lack of understanding and direction, corruption, fast urbanization, the dumping of used goods into developing nations by the developed world, and a lack of resources and funding. Nevertheless, this research has been able to shed more light on the existing state of affairs and the detrimental effects of careless trash disposal in developing nations. It has also suggested a sustainable alternative strategy for progressively achieving a good amount of waste reduction. The 3Rs—Reduce, Reuse, and Recycle—are a comprehensive strategy that anybody can readily implement to daily objects which have the potential to produce trash. Environmental education is necessary, nevertheless, as it imparts important knowledge about waste management to both children and adults by using the 3Rs, which promote moral and sustainable environmental behaviour. And educate everyone in the community on the benefits of recycling, reusing, and reducing trash. We should strive to incorporate recycling, reducing, and reusing habits into our daily routines and lifestyles so that they become the norm rather than the exception, in addition to employing awareness and caution in all that we do. Local governments should take more steps to encourage the implementation of the 3R principle by setting up Drop-off programs for collection through the use of containers on streets, planning waste management events and rallies, and providing financial incentives to homeowners that can increase participation and recycling rates. Additionally, by promoting the idea that people pay less if they recycle, they can also help to increase recycling rates. Also, everyone, businesses, and organizations can help achieve the sustainable development

objective of zero waste and environmental preservation by providing practical answers to the What and How questions related to day-to-day operations and by putting the 3Rs waste prevention strategy into practice.

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RESEARCH ARTICLE

A Systematic Computational Approach to Unveil the Potent SNPs of Human luteinizing hormone receptor (LHCGR)

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ABSTRACT

Polycystic ovarian syndrome (PCOS) is a prevalent complex endocrine condition among reproductive women. The luteinizing hormone chorionic gonadotropin receptor (LHCGR), which is its receptor, and the related downstream signaling cascade are crucial in the origin of PCOS. Although PCOS risk has been linked to genetic polymorphisms in the LHCGR, evidence to support this remains disputable. The study aims to investigate the impact of single nucleotide polymorphisms (SNPs) in the LHCGR gene on protein function, structure, and stability. The findings revealed that out of 637 missense SNPs in the LHCGR gene, 16 were deleterious to the protein. These SNPs were found to be destructive to the structure and function of the LHCGR molecule and may play a crucial role as molecular determinants of PCOS development.

Keywords: Polycystic ovarian syndrome (PCOS), luteinizing hormone chorionic gonadotropin receptor (LHCGR), single nucleotide polymorphisms (SNPs)

INTRODUCTION

Polycystic ovarian syndrome (PCOS) increases the risk of significant problems in women. One in every 5-6 females is dealing with major difficulties related to infertility and irregular menstrual cycles [1]. As a complex endocrine condition, the pathogenesis of polycystic ovarian syndrome (PCOS) is still unclear. It is characterized by low gonadotropin levels, large multi-follicular ovaries, infertility, and obesity. This complicated pathology has an association with hyper and rogenism [2]. Although it is almost certain that elevated androgen levels had a part in the development of PCOS, the patho physiology of the condition is not fully understood. A dysfunctional hypothalamic-

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pituitary-gonadotropin (HPG) axis is a major contributor to ovarian failure. Many potential genes have been examined along the HPG axis, including follicle-stimulating hormone (FSH), FSH receptor, luteinizing hormone (LH), LH receptor (LHCGR), androgen receptors, and sex-hormone binding globulin [3]. The LH receptor gene contains a substantial number of single nucleotide polymorphisms (SNPs) [4]. Several studies have been conducted to investigate the relationship of susceptible SNPs, which may alter gene expression or protein function in LHCGR and PCOS [5]. The LHCGR gene is a single-copy gene with 11 exons and 10 introns identified on the short arm of chromosome 2 (2p16.3) [6]. The mature form of the LHCGR that is visible on the cell surface is a polypeptide with 675 residues and a prominent molecular mass of 85–95 kDa [7]. LH mediates the subsequent cellular processes when it attaches to its receptor, the luteinizing hormone chorio-gonadotrophin receptor (LHCGR). The function of both LH and choriogonadotropin during the production of steroid hormones is regulated by a G-protein coupled receptor known as the LHGCR, which is expressed on the theca cells of the ovaries. The ovary's ability to function and the diseases that they are linked to, including PCOS, will be affected by any mutations that alter the LHCGR protein's structure or function [8]. Further research is necessary to determine whether polymorphism may play a role in additional steroid hormone-related disorders, as LH is one of the most significant regulators of ovarian steroid hormone production.

METHODOLOGY

Data Mining

The human *LHCGR* gene accession number (NCBI Gene ID: 3973), missense SNPs, and amino acid changes were obtained from the NCBI dbSNP database (https://www.ncbi.nlm.nih.gov/snp/?term=LHCGR) database. The UniProt (https://www.uniprot.org/) database was used to produce the FASTA format sequence for the protein with the UniProt entry name (LSHR_HUMAN) and UniProtKB number (P22888) of Lutropin-choriogonadotropin hormone receptor. Free online software tools were utilized to analyze if an amino acid change impacts the targeted protein, as well as to identify deleterious/damaging SNPs and 3-D models of the mutated protein (FIG 1) [15]. The functional study of missense SNPs was performed using five software programs. The SIFT (https://sift.bii.a-star.edu.sg/) determines the amino acid effects on protein function using specific characteristics of amino acids and homology [16]. PolyPhen-2 (http://genetics.bwh.harvard.edu/pph2/) analyzes amino acid substitutions in a sequence and provides information on their evolutionary and structural relationships [17]. SNPs & GO (https://snps.biofold.org/snps-and-go/) calculates whether a variant is potentially linked to a disease or is neutral [18]. The SNAP2 server (https://rostlab.org/services/snap/) uses a "neural network," a machine learning tool, to anticipate the functional impact of mutations [19]. The PANTHER (https://www.pantherdb.org/)tool forecasts the negative consequences of missense SNPs. It uses the Hidden Markov model (HMM) to calculate the substitution position-specific evolutionary conservation (sub-PSEC) ranking to determine whether the Amino Acid replacement leads to any functional changes [20].

Prediction of Protein Stabilization Alteration
I-Mutant 3.0 and MUpro, two SVM-based predictors, were used to forecast changes in protein stability [15], [16].

Prediction of Biophysical and physiochemical properties
Project HOPE was used to create 3D models of mutant proteins and their amino acid sequences in order to analyze the variations in size, charge, hydro phobicity, and other properties of these proteins [17].

3D structure generation and validation

Homology modeling is the technique for creating the three-dimensional structure of a completely novel or altered protein (the "target protein") by utilizing information about the structure of a protein that resembles it (the "template protein"). I-TASSER software is being used for homology modeling. It is an approach for modeling the hierarchical organization of proteins that is based on secondary structure enhanced Profile-Profile threading Alignment (PPA) and the iterative Threading Assembly Refinement (TASSER) algorithm [18]. The Galaxy program was used to enhance the protein model after the 3D structure synthesis. It increases the global and local structure quality of the average model created by three-dimensional prediction servers [26]. Validation of the generated model: The model selected is subsequently run through PROCHECK's stability analysis to generate a Ramachandran plot [19].

RESULTS

Results obtained for *LHCGR* using functional analysis tools

The data of the *LHCGR* gene were collected from dbSNP (NCBI), a widely used database. It has total 30396 SNPs out of which 637 missense SNPs selected and analyzed using functional and structural analysis tools. The following are the results obtained for *LHCGR* Gene with protein id: NP_000224.2. The protein sequence of the *LHCGR* gene was derived using UniProt and the FASTA sequence so obtained was analyzed using different tools. The different variants were analyzed using Polyphen-2 out of which 369 variants were obtained as probably damaging. SIFT signifies the results in the form of deleterious or tolerated. 54 variants were obtained as deleterious. The variants were further analyzed using SNPs and GO. 50 of them were found to be disease. On analyzing all the variants with Panther 74 variants were found to be probably damaging. SNAP2 gives the results in the form of effect and neutral. 83 variants were obtained as effect. Considering results obtained from all of the functional analysis tools 16 variants were selected which were probably damaging, disease, effect, and deleterious individually shown in **Table I**.

Results obtained for LHCGR using structural analysis tool.

I-mutant and Mu-PRo are used to predict the structural stability of the SNPs. It gives the value of the free energy(ddG) and the stability of the variant. Using these 16 variants were obtained with free energy <0 and decreased stability as shown in **Table II**.

Results of project HOPE

Project Hope server revealed the structural characteristics of a single amino acid change in the mutant protein. All 16 ns SNPs are predicted by HOPE to have imperfections in size, charge, hydro phobicity, and all of which are located in highly stable regions **(Refer to Table III).** The normal residue is represented in green colour and the abnormal residue is represented in red colour.

Results of Modelling and structure validation.

The structural integrity of proteins can be significantly changed by altered SNPs. In order to investigate the structural stability, three-dimensional models of mutant proteins were built. I-TASSER was utilized to anticipate the LHCGR 3D structure (Fig 2). The Ramachandran plot shown in FIG 3, which investigated overall structure geometry, was used to assess the mutant model reliability encapsulated in Table IV. Table IV encapsulates the results of the Ramachandran plot which showed that out of 699 residues, 450 (71.2%) were in the regions that were most favored,

146 (23.1%) were in regions that were additionally allowed, 23 (3.6%) were in regions that were generously allowed, and 13 (2.1%) residues were in regions that were disallowed.

DISCUSSION

PCOS is distinguished by hyper and rogenism, obesity, polycystic ovaries, and irregular menstrual cycles/anovulation [20]. Numerous potential genes have been suggested as significant PCOS contributors [21]. In PCOS genetic association studies, many researchers chose genes that regulate steroid production, the Hypothalamic-Pituitary-Gonadal system, obesity, and inflammatory processes [3]. In Silico screening can identify the phenotypic impact of missense variations on the biological and chemical properties of a particular protein. The data gathered assists in understanding the involvement of the *LHCGR* gene in a therapeutic condition. In the current study, we assessed the significant *LHCGR* variants as an associated risk factor for PCOS. SNPs have associations with both phenotypic and genotypic traits that differentiate people. In the codon-rich regions of the human genome, there are about 500000 SNPs that are very important [22] Among these, missense SNPs play an essential role in human disorders because they account for a single amino acid variation that may contribute to a functional alteration in a protein [23]. SNPs that cause functional alterations may have an adverse or minimal impact on the protein structure [24]. The pathogenic effect of variations was responsible for a modification in protein structure [25] . This adverse impact led to changes in protein hydrophobic nature and energy [26]as well as disrupting connections between and within the proteins [27]. As a result, the structural stability of the cell is compromised [28]. Based on the information presented above, we can conclude that nsSNPs play an important role in numerous human disorders. The present study unveiled that 16 SNPs have affected the structure and functionality of the LHCGR protein A593P T577I S616Y M398T C131R A373V E354K I625K I542L D578H A568V L457R C343S C543R L502P G504S.

Toledo and his colleagues explained that the Ala593 to Pro alteration in the sixth trans membrane segment most likely causes the receptor molecule to fold abnormally during its formation and alterations in the endoplasmic reticulum and Golgi apparatus. This might lead to poor trafficking, which would then cause less expression at the plasma membrane. In such a situation, ovarian LH resistance is connected with regular growth of female genitals on both sides and Ovulation fails to occur, followed by possible infertility [29]. Another study done by Byambaragchaa et al.,2021 demonstrates that in humans, naturally occurring mutations such as M398T, L457R, D564G, and D578Y are known to exhibit continuous activation, resulting in a hike in the basal cAMP response and a faster loss of the cell-surface receptor[30]. A human LHR mutant lacks hormone binding due to the Cys131Arg mutation. Unexpectedly, the stimulating effect of interacting structures and wild-type human LHR with either hLH or hCG exhibited variations in the trans-activation and cis-activation mechanisms of the two hormones. Grzesik et al. 2014 showed that neither the point mutations that were introduced, such as Cys131Arg and Lys605Glu, nor the absence of exon 10 altogether had a substantial impact on receptor oligomerization. These outcomes demonstrated that exon 10 is not necessary for the oligomerization of hLHR-delExon10. Furthermore, it rules out the idea that the observed decline in hLH-mediated signaling in comparison to hCG or wild-type hLHR is caused by reduced oligomerization of hLHR-delExon10.Contrary to hCG, the absence of exon 10 significantly affects how hLH stimulates cAMP. Cys131Arg inserts into the hormone-binding region and the significant positive charged side chain of arginine is likely to disrupt the pattern of corresponding receptor-hormone interaction [31].

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Two homozygous inactivating nonsense and missense variants of the LH-receptor gene were reported by Latronico and his companions in 1996 —Arg 554 stop codon 554 (TGA) and Ser 616 Tyr 616, respectively—were discovered in a 46, XX sister with amenorrhea [32]. According to Oliveira et al. 1994 the stop codon present in the 3rd intracellular loop of the LH receptor might prematurely halt the translation of the receptor's mRNA and, as a result, remove a significant portion of the receptor. This abbreviated mutant receptor would not be able to transmit the hormone signal even if it were expressed in the membrane of the target cells [33]. Latronico et al. 1996 in their study reported a patient having ovaries with cysts of different diameters and a small uterus. The former suggested a reduced systemic estrogenic influence on the uterus, and the latter could be an indication of non-luteinized degenerating follicles. On molecular analysis, the Tyr 616 alteration was found in this critical area of the LH receptor. His findings may explain the LH-receptor gene abnormality which rendered the receptor inability to bind LH effectively [32]. *LHCGR* mutations are not prevalent compared to other genetic and non-genetic causes of hypergonadotropic hypogonadism with similar symptoms. However, it is essential to keep these disorders in mind while making a differential diagnosis for empty follicle syndrome, oligoamenorrhea, and infertility [34]. Finally, it is worth noting that most LHCGR mutations have no or limited effects on the reproduction process in females. However, some suppressing polymorphisms have been linked to polycystic ovarian syndrome [35], empty follicle syndrome [36], infertility [37], oligo/amenorrhea [38], and infertility [37], [39]. The In-silico approach is mainly to narrow down the lab-based studies. The findings of this study need to be confirmed by research experiments to mitigate the possibilities of increasing the clinical and reproductive health conditions associated with the PCOS phenotype.

CONCLUSION

In genetic correlation studies, computational methods are highly useful since they reduce the expense of SNP genotyping. In the *LHCGR* gene, the current investigation found a total of 16 non-synonymous/missense SNPs: A593P T577I S616Y M398T C131R A373V E354K I625K I542L D578H A568V L457R C343S C543R L502P G504S having a deleterious impact on each of the 10 computational tools for both structure and function. Our findings lead us to believe that these non-synonymous SNPs may be responsible for the etiology of PCOS. In summation, LHCGR variants might be significantly linked to risk for disease, and LHCGR polymorphisms contribute to a significant difference in the phenotype of PCOS, suggesting that the LHCGR polymorphisms could be used as a molecular marker to identify women at risk of developing PCOS in our population.

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Table 1 : Results obtained for *LHCGR* using functional analysis tool.

rsID	position		AA change	Polyphen-2	SIFT	SNP & CO	PANTHER	SNAP 2
rs121912520	593	A	P	PD	DEL	D	PD	E
rs121912521	577	T	I	PD	DEL	D	PD	E
rs121912525	616	S	Y	PD	DEL	D	PD	E
rs121912526	398	M	T	PD	DEL	D	PD	E
rs121912527	131	C	R	PD	DEL	D	PD	E
rs121912528	373	A	V	PD	DEL	D	PD	E
rs121912529	354	E	K	PD	DEL	D	PD	E
rs121912530	625	I	K	PD	DEL	D	PD	E
rs121912531	542	I	L	PD	DEL	D	PD	E
rs121912532	578	D	H	PD	DEL	D	PD	E
rs121912534	568	A	V	PD	DEL	D	PD	E
rs121912535	457	L	R	PD	DEL	D	PD	E
rs121912536	343	C	S	PD	DEL	D	PD	E
rs121912537	543	C	R	PD	DEL	D	PD	E
rs121912538	502	L	P	PD	DEL	D	PD	E
rs377391010	504	G	S	PD	DEL	D	PD	E

Table 2. Results obtained using structural analysis tools.

rsID	position	AA change		I-MUTANT	MU-PRO
rs121912520	593	A	P	-1.25	-2.16
rs121912521	577	T	I	-0.75	-0.60
rs121912525	616	S	Y	-0.46	-0.47
rs121912526	398	M	T	-1.44	-1.7
rs121912527	131	C	R	-0.37	-2.04
rs121912528	373	A	V	-0.41	-0.16
rs121912529	354	E	K	-1.05	-1.24
rs121912530	625	I	K	-3.07	-3.16
rs121912531	542	I	L	-0.36	-0.26
rs121912532	578	D	H	-0.09	-0.64

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rs121912534	568	A	V	-0.87	-0.74
rs121912535	457	L	R	-2.03	-0.92
rs121912536	343	C	S	-2.05	-1.92
rs121912537	543	C	R	-0.64	-1.31
rs121912538	502	L	P	-1.34	-1.1
rs377391010	504	G	S	-0.77	-0.05

Table 3. Structural Variation of the Normal Residues by Abnormal Residues Demonstrated by Project Hope.

rsID	HOPE 3D Structure	rsID	HOPE 3D Structure
rs121912520 **A593P**		**rs121912531** **I542L**	
rs121912521 **T577I**		**rs121912532** **D578H**	
rs121912525 **S616Y**		**rs121912534** **A568V**	
rs121912526 **M398T**		**rs121912535** **L457R**	
rs121912527 **C131R**		**rs121912536** **C343S**	
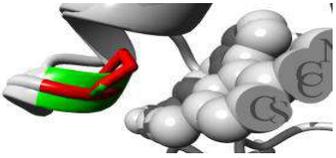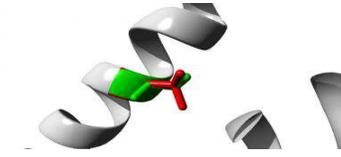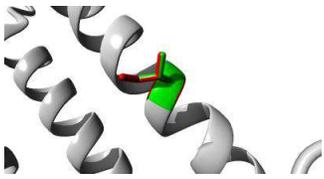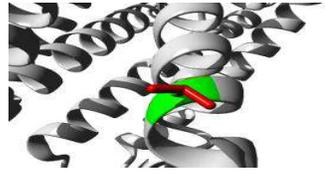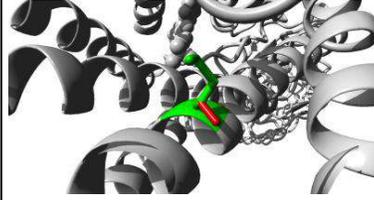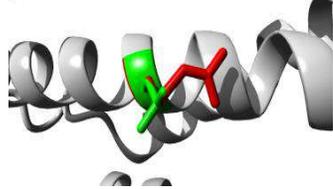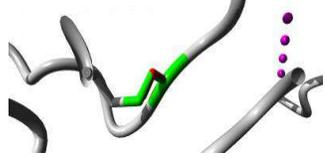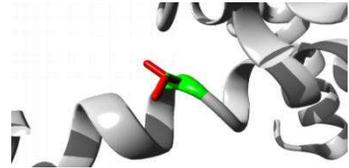
rs121912528 A373V		**rs121912537 C543R**	
rs121912529 E354K		**rs121912538 L502P**	
rs121912530 I625K		**rs377391010 G504S**	
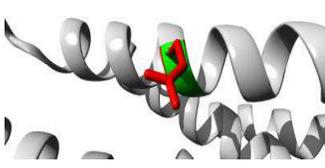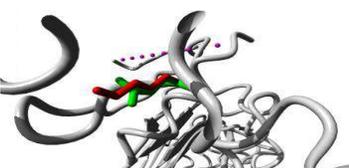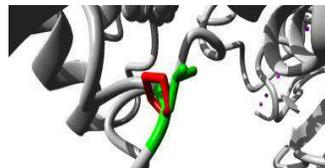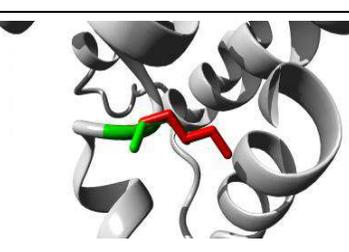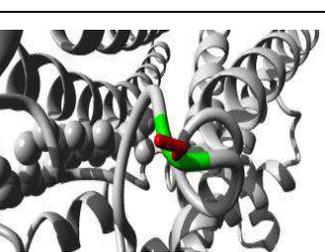
Table 4. Showing the plot statistics of the LHCGR protein.

Residues in most favoured regions	450	**71.2%**
Residues in additional allowed regions	146	**23.1%**
Residues in generously allowed regions	23	**3.6%**
Residues in disallowed regions	13	**2.1%**
Number of non-glycine and non-proline residues	632	**100%**
Number of end-residues	2	
Number of glycine residues	30	
Number of proline residues	35	
Total Number of residues	**699**	
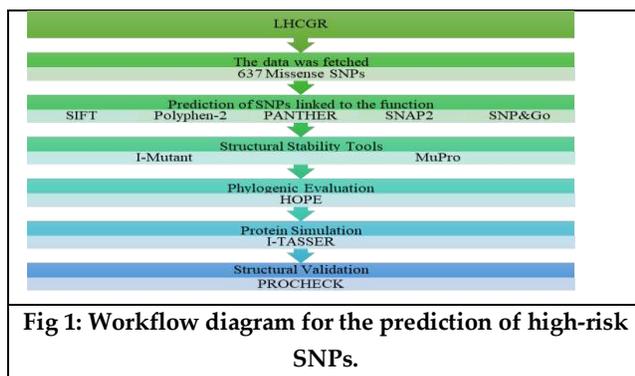
Fig 1: Workflow diagram for the prediction of high-risk SNPs.	**Fig 2: 3D model of LHCGR protein obtained using I-TASSER.**
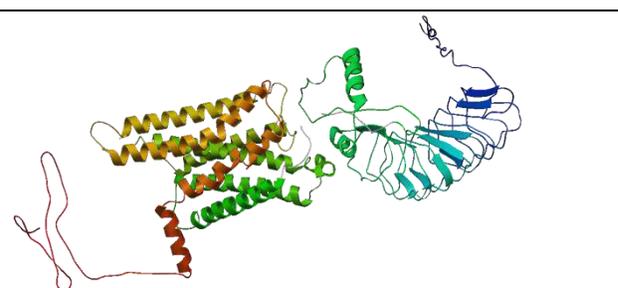
Fig **3:structural validation by Ramachandran plot of LHCGR protein**

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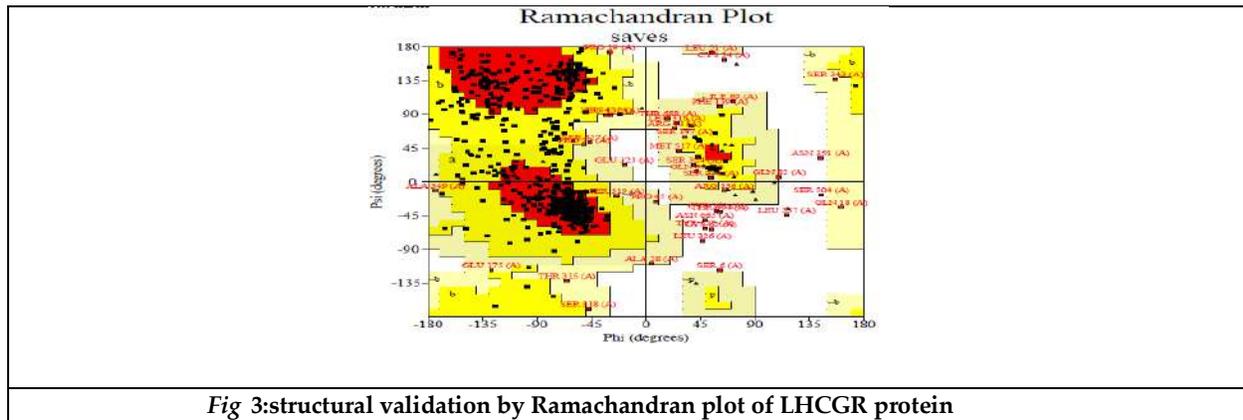
Social Media: Social Networking Sites, Significance of Self-Confidence and Addiction

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ABSTRACT

In this study, social media addiction in young people was explored, along with the role of self-confidence as a mediating factor and any potential negative effects. There has been a decline in the previous 10 years and significant growth in research on social networking addiction. This study's objective was to more clearly and thoroughly analyze the relevance of self-confidence, social networking sites, and the reasons for social media addiction among those who identify as such. The study also revealed that there is a start phase and a continuation phase to social media addiction. It has been shown that young people in the initial stages of using social media did so for a variety of reasons, including boredom, loneliness, and a lack of social interaction. In the continuation stage of young people's addiction, they claimed to utilize social media to safeguard their existing social relationships and to meet obligations. The urge to socialize was friends than female participants were in talking to their friends.

Keywords: social media, addiction, social networking, youths.

INTRODUCTION

Internet use is a knowledge technology that has impacted many facets of society by facilitating communication, trade, and information. Although its development was intended to provide safe, quick, affordable information and to ease communication, it has now evolved into a tool for bringing about enormous changes in people's lives and society. The internet's ability to be used anywhere, at any time, in a virtual setting has changed how people communicate. Additionally, social media, a development of internet technology, alter how individuals communicate with one another. The usage utilizes social media expanding globally, particularly among young people who have a keen interest in it. The usage of social media in daily life has increased during the past ten years. On the other hand, when people spend a lot of time online, internet-related activities might stop functioning as intended, which can have negative effects including troublesome and addictive behaviours (Griffiths; LAROSE, KIM and PENG). Among the different study areas looking at online addictive behaviours, social networking site addiction has received greater attention recently (SNSs). SNSs are online communities where users may build public profiles, communicate with friends in real life, and connect with others who share their interests to maintain both online and offline connections (D. Griffiths; Kuss and Griffiths; Kuss and Griffiths). The components model of addiction included six criteria that could also be applied to SNS addiction, including mood modification (i.e., engagement in SNSs leading to a favourable change in emotional states), salience (i.e., behavioural, cognitive, emotional, and SNS use obsession), tolerance (i.e. the ever-increasing SNS usage over time), and withdrawal. The paradigm of Internet-related diseases, which highlighted how commonplace actions tend to be overly anthologized and treated as addictions, has drawn some criticism, though (Kuss and Griffiths).

The Significance of Self-confidence
Self-esteem is one aspect that could contribute to the harmful impacts of social media addiction. Although looking at or changing one's internet presence boosts confidence, according to the hyper-personal Model, Users of social media are regularly exposed to others' carefully curated and glorified online self-presentations, which may diminish their interest. Self-confidence for example, when they don't know the other users well, regular Face book users tend to think that others are happier and more successful than they are offline. They also suggest that the extent of higher social comparisons based on Face book is greater than the extent of downward social media, comparisons and upward social comparisons may lower self-esteem. This idea has received support from empirical investigations. For example, a study showed that the use of Face book usage was linked to lower self-esteem, thus those who used it more frequently had lower self-esteem of time on Face book per session and those who made a greater number of Face book logins per day had lower self-esteem. Another study discovered that teenagers' self-esteem decreased after hearing unfavourable feedback on social media. Moreover, recent studies have revealed a negative relationship between social media use which is compulsive and self-esteem. A considerable number of studies have shown that low self-esteem is associated with many psychological dysfunctions such as depression and anxiety. Self-esteem has also been shown to be positively associated with academic performance and further serves as a protective factor against adversities in aiding academic and emotional resilience. It's likely that social media addiction makes people feel less confident about themselves, which in turn affects their mental health and academic performance. Otherwise put, self-confidence may play a mediating role in the relationship between the impact of social media addiction on academic performance and mental health (Rosenberg and Egbert; Raskauskas, Rubiano and Offen).

Social Media Addiction
Although the usage of mobile social media as a whole was not specifically included in any of the earlier research, it is reasonable to infer that the findings of computer-based Internet addiction also apply to mobile Internet since they fundamentally employ the same medium. Mobile phones are now identical to personal computers in terms of Internet addiction thanks to the inclusion of always-on Wi-Fi and the proliferation of free social networking apps. Additionally, mobile phones, as their name suggests, are portable and offer simple access to the Internet whenever and wherever. They are the perfect medium for Internet junkies because of this.

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From a psychological perspective, social media provide a diverse array of experiences, each with potent components that may encourage problematic behaviour. For instance, an extrovert could spend a lot of time on Face book and compulsively check their page to see how many people "liked" their most recent post. Insta gram may prove to be an addicting platform for those with narcissistic tendencies to use to show off their appearance to others by taking "selfies." using social media excessively also be fuelled by social anxiety. The primary driver of excessive social media use, regardless of the time of day and at the detriment of other pursuits, may be FOMO (Przybylski, Murayam and DeHaan). Sometimes the term "mobile phone addiction" is used to set it apart from the idea of Internet addiction. The majority of conventional research on online addiction ignores problematic mobile phone use. In addition to voice and video conversations, text messaging, video recording, and a wide variety of entertaining apps made specifically for small displays, mobile phones currently provide access to nearly all Internet applications. Additionally, any screen can display their findings.

They also have the advantage of constantly being accessible, unlike a desktop or even a laptop. You may use your phone while driving, taking public transit, or even when you're out and about. Before this, consumers could not participate in a diverse array of online activities within these "micro periods." This can result in compulsive mobile phone use, disrupt in-person interactions, and impair academic achievement (Al-Menayes). Although there is little research on problematic mobile media use, interest has lately grown. For instance, a study of female Taiwanese college students indicated that those who performed well on a test for smart phone addiction had higher levels of extraversion and anxiety as well as a little decline in self-esteem. Compared to males, women appear to be more susceptible to smart phone addiction (Hong, Chiu and Huang). Another use of mobile phones, "texting," which can be done directly or through social media sites like Twitter and similar apps, may prove to be particularly significant for addictive behaviour. Recent polls show that young people are beginning to use Twitter instead of Face book, especially as their parent's accounts and request to be friends. Such programmes are expanding and enabling an increasing number of features, such as Vine, which enables users to produce six-second films to share with followers. The main characteristic of these programmes is their stickiness, or their inclination to be often used by users. Their business models, which rely on the expanding volume of data on user activity to share with advertisers for targeted marketing, are the cause of their stickiness (Madden, Lenhart and Cortesi).

The Negative Outcomes of Social Media Addiction
One type of Internet addiction is social media addiction, which manifests as a need for using social media excessively. People who have a social media addiction frequently have excessive social media anxiety and are motivated by an overwhelming want to access and utilize social media. According to studies, social media dependency causes issues with emotion, mental acuity, physical and emotional reflexes, interpersonal relationships, and psychological well-being (Alabi; Wolniczak, Cáceres-DelAguila and Palma-Ardiles; Wu, Cheung and Ku). Numerous social media usage and mental health research have found a negative correlation between long-term well-being and media use, as well as a positive correlation between mental health issues including stress, anxiety, and depression. For instance, high school students in Central Serbia and young people inside the United States both showed a positive correlation between the amount of time spent on social media and depression symptoms. Furthermore, it has been demonstrated that some types of using social media are linked to poorer academic achievement. For instance, (Lau) discovered that while social media use for academic reasons did not predict academic success as measured by the cumulative grade point average, social media use for non-academic purposes (particularly video gaming) likewise, social media multitasking. Additional support for the inverse relationship between academic usages of social media outcomes has been offered by laboratory studies. Weibo, Twitter's counterpart in China, was discovered by (Jiang, Hou and Wang) to have detrimental consequences on information comprehension. It is important to note that frequent social media use does not always imply addiction, and that usage of social media often does not always have a detrimental impact on people's mental health or academic performance. One important contrast between regular overuse of social media, which many people may experience periodically, and reliance on social media is that the latter is linked to negative outcomes when online social networking becomes obsessive and uncontrolled. Social Media addiction has been a major subject of studies. It has been demonstrated that social media addiction is adversely connected with subjective well-being, subjective vigour,

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and life satisfaction and is favourably associated with sadness, anxiety, and sleeplessness. Additionally, studies have revealed that social media addiction has a detrimental effect on academic achievement.

CONCLUSION

By this study, social media addiction is caused by a lack of friends, the perception that using social media is an activity, the need to complete a task, they want to keep up with current events, and the desire to mix social media with real life. There was no difference in the study between men and women. For females, however, the demand for sociability manifests itself through communication with actual friends. This circumstance has been seen to lead to guys creating more new buddies. The starting and continuation phases of addiction to social media have also been identified. People who are in the early stages of addiction have been discovered to frequently use social media to pass time when they are bored, lonely, or unable to make friends. Individual who is in a period of continuity addiction utilises social media to keep up with happenings, feel like they have fulfilled their obligations, safeguard their social connections, and other things.

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RESEARCH ARTICLE

Thermoelectric Properties of Iron Oxide: Synthesis and Characterization

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ABSTRACT

Iron Oxide (Fe_3O_4) nano particles are synthesized via the sol-gel method. The functional groups, crystal structure and surface morphologies of the ZnO nano particles are investigated by Fourier transform infrared spectroscopy (FTIR), X–ray powder diffraction and scanning electron microscopy (SEM) respectively. The thermo electrical properties were also analyzed. From SEM observations, spherical particles are noticed for nano particles. As the temperature increases from 30°C to 90°C, the electrical conductivity of the nano particles increases from 8.75 to 22.07mS/cm and the thermal conductivity decreases from 0.976 to 0.664 $Wm^{-1}K^{-1}$. Here, as the annealing of zinc oxide increases, the thermoelectric properties of the nano particles improve.

Keywords: Iron oxide, Nano particles, Electrical conductivity, Thermal Conductivity

INTRODUCTION

Thermoelectric (TE) materials have received a lot of attention recently due to their potential usage in the electricity generation refrigeration, and thermal sensing [1]. Low temperature variations, albeit frequently available in the environment (such as from solar and geothermal energy) or produced from various power generating or consuming systems, are insufficient for the production of electricity using conventional systems [2]. The conversion of waste heat to electric power by means of thermoelectric devices has grown more urgent and significant, especially since the combustion of fossil fuels has generated highly worrisome environmental problems [3]. High electrical conductivity and low thermal conductivity is the significant for good thermoelectric materials [4]. Traditional inorganic semiconductors with excellent thermoelectric characteristics, such as Bi_2Te_3, PbTe, SiGe, $CoSb_3$, and SnSe have

garnered the most interest. However, the expensive price and challenging processing prevent these inorganic thermoelectric materials from being used widely [5]. Due to their inherent low thermal conductivity, light weight, low processing cost, and mechanical flexibility, some nano particles are viewed as suitable replacements [6]. The thermoelectric properties of Fe_3O_4 have been studied well in the literature. The addition of iron oxide to the corresponding conducting polymer further enhances the thermoelectric properties of the nano composite [7]. In this study, Fe_3O_4 nanocomposites were fabricated by sol – gel method at room temperature and the nano particles were characterized by conventional technologies. The electrical conductivity and thermal conductivity were also calculated. The TE properties of the nano composites were measured from 30°C to 90°C.

Experimental Procedure
Materials
Ferric sulphate ($Fe_2(SO_4)_3$) ≥99% purity (HmbG Chemicals), Ammonia solution (NH_4OH) ≥98% (Sigma Aldrich), Ethanol (CH_2COOH) HmbG Chemicals) and distilled water. All reagents were analytical grade and directly used without further purification.

Synthesis of iron oxide nano particles
Ferric sulphate (2.6g) was dissolved in 20mL of distilled water. 20mL of ammonia solution is taken in a beaker. This ammonia solution is added drop wise to the ferric sulphate solution. This mixture is stirred for three hours. The Solution is allowed to rest for few minutes till the white precipitate forms. Finally, the collected precipitate was filtered using what man filter sheet. Then it is transferred to a petri dish and dried in oven at 80°C.

RESULTS AND DISCUSSION

Fourier Transform Infra-Red Spectroscopy
The FTIR is the best tool to analyze the functional groups of nano composites and it has been recorded at the region of 4000-400 cm^{-1}. Figure 1 displays the FTIR of iron oxide nano particles as a red line. The distinctive peak of C-H bond in FTIR spectra is the peak with wave number 2922 cm^{-1}. The bonds in the region 1627 cm^{-1} corresponded to the polyester resins. The peak at 3429 cm^{-1} was attributed to the O-H stretching vibration arising from the hydroxyl group. The peak 2853 cm^{-1} is associated with the vibration of CH_2. The stretching vibrations of Fe-O are corresponding to 472 and 547 cm^{-1}. These peaks provide evidence that the particles being studied are Iron Oxide nano particles [8].

Scanning Electron Microscopy
Scanning electron microscopy is the best tool to analyze the surface morphology of the samples. The SEM image of iron oxide is shown in figure 2. The morphology of the nano particles was observed to be spherical. The figure showed the particle size ranging from 85 to 95nm. The SEM image of iron oxide nano particles confirmed it consists and spherical shaped nano particles [9].

X-Ray Diffraction
Structural analysis was performed using X-ray diffraction technique. Figure 3 shows the X-ray diffraction pattern of iron oxide annealed at 300°C. The major XRD peak is observed at 2θ value of 33.04° while the secondary major peak is recorded at 35.51°. Other peaks are found at 2θ = 53.93° and 62.47°. These peaks corresponds the iron oxide with the hkl values of (104), (311), (116) and (214). The hematite structure could be identified by the XRD patterns of Fe_3O_4 nano particles. The hematite phase is more prominent phase of iron oxide nano particles [10]. The primary measurement to examine the thermo electrical properties is electrical conductivity. This allows for an assessment of the quality of the created nano composites. As the temperature increases from 30°C to 90°C, the electrical conductivity of the nano composites was evaluated. Figure 4 displays the electrical conductivity of iron oxide nano particles. It has been shown that electrical conductivity increases with increasing temperature. The electrical conductivity for iron oxide is 22.07 mS/cm. At 90 °C, all of these results were obtained. Here, when the temperature rises, the ions move more quickly due to their increased kinetic energy. They conduct their bearing charge faster

rapidly, increasing electrical conductivity as a result. So the electrical conductivity increases as the temperature and weight ratio increases [11].

Thermal Conductivity

When analyzing the thermoelectric characteristics of nano composites, thermal conductivity is a vital factor to comprehend. The measurement of thermal conductivity was done between 30°C to 90°C. Figure 5 illustrates the thermal conductivity of iron oxide nano particles. As the temperature is increased, the thermal conductivity of iron oxide nano particles reduces. The thermal conductivity of iron oxide is 0.976 Wm-1K-1 at 30 °C. It has thermal conductivity of 0.664 Wm-1K-1 at 90 °C, respectively, and these values decrease as temperature increases. As the weight percentage rises, the thermal conductivity of nano composites diminishes. Because an harmonic scattering is inversely proportional to temperature changes, it causes the thermal conductivity of Fe_3O_4 nano particles to decrease at higher temperatures [12].

CONCLUSION

Iron oxide nano particles were synthesized by sol-gel method. Iron oxide has sphere nanostructure. Electrical and thermal conductivity were characterized. As the temperature increases from 30°C to 90°C, the electrical conductivity of the nano composites increases from 8.75 to 22.07mS/cm and the thermal conductivity decreases from 0.976 to 0.664 $Wm^{-1}K^{-1}$. We have concluded that the zinc oxide nano particles can be used to make thermoelectric materials.

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Fig. 1.FTIR graph for iron oxide

Fig. 2.SEM image for iron oxide

Fig. 3. XRD graph for iron oxide

Fig. 4. Electrical conductivity image for iron oxide

Fig. 5.Thermal conductivity image for iron oxide

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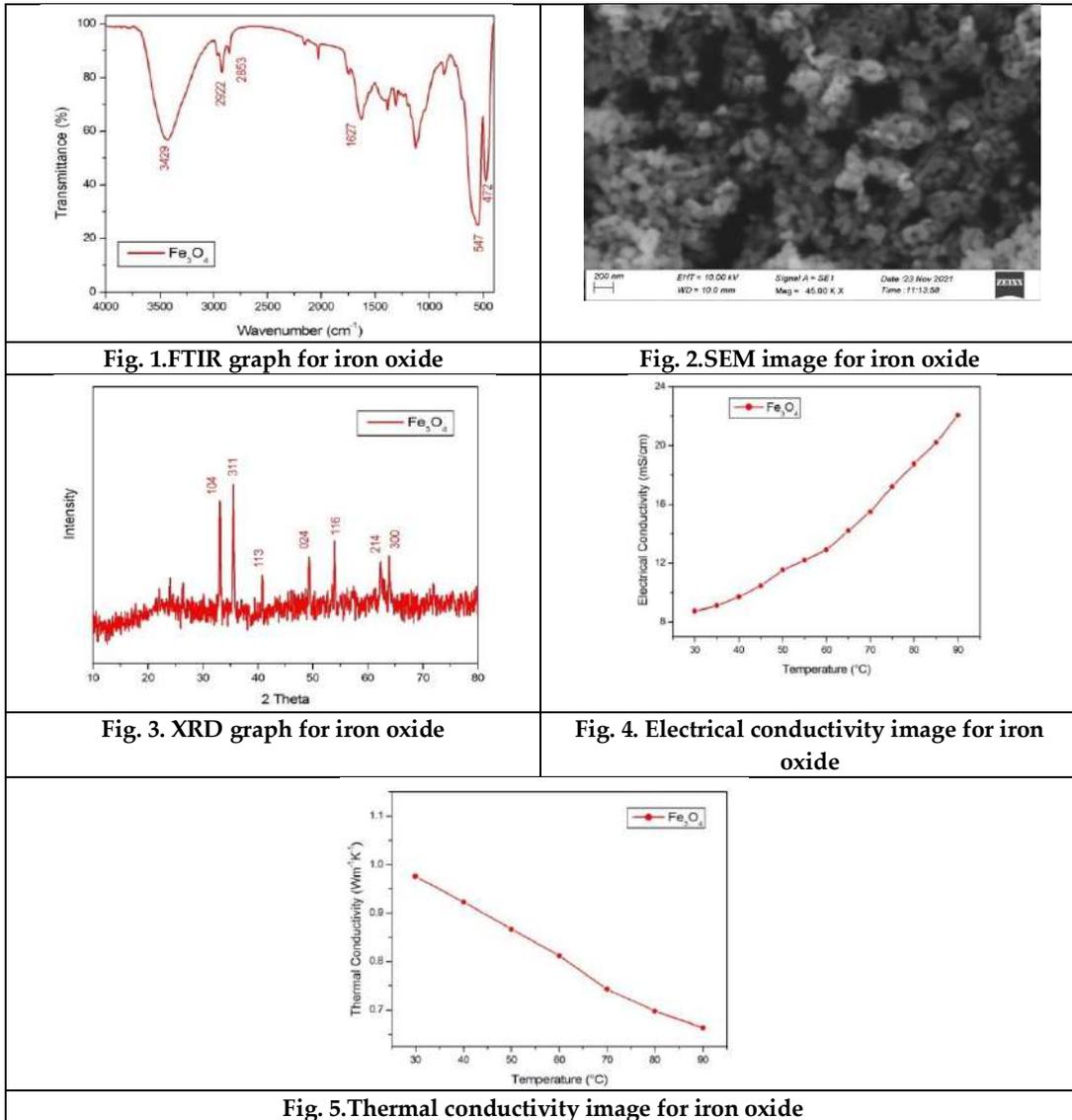
Applications of Machine Learning and Artificial Neural Networks in Thermal Engineering

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ABSTRACT

The application of Machine Learning (ML) and Artificial Neural Networks (ANNs) in the field of thermal engineering has emerged as a transformative approach to address complex challenges associated with energy efficiency, sustainability, and system optimization. Thermal engineering encompasses a wide array of applications, from heating, ventilation, and air conditioning (HVAC) systems to power generation, refrigeration, and industrial processes. ML and ANN techniques are being leveraged to revolutinize these domains. ML also aids in fault detection in HVAC systems, green building design for sustainable architecture, and nuclear reactor safety through condition monitoring. This article tries to cover how ML and ANN have become indispensable tools in the field of thermal engineering, offering innovative solutions to optimize energy use, improve system reliability, enhance sustainability, and drive progress toward a more efficient and environmentally responsible future.

Keywords: Thermal, AI, ML, ANN, Applications

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INTRODUCTION

Machine learning (ML) and artificial neural networks (ANNs) have numerous applications in thermal engineering, enhancing the design, operation, and optimization of thermal systems. In HVAC systems, ML algorithms are deployed to optimize energy consumption by learning from real-time data and adapting system parameters for efficient operation while maintaining occupant comfort. Predictive maintenance models based on ANN predictions enable proactive component monitoring and reduce downtime, thereby improving system reliability. ML plays a pivotal role in load forecasting for power generation and distribution, contributing to the efficient utilization of resources and reducing greenhouse gas emissions. Heat exchanger design benefits from ML-driven optimizations, leading to enhanced heat transfer efficiency and reduced costs. Moreover, thermal comfort prediction models assist in designing indoor spaces that provide ideal comfort levels. Industrial processes, such as combustion systems, are being optimized using ML algorithms, resulting in improved efficiency and reduced emissions. Fluid flow simulations are expedited through neural networks, enabling faster and cost-effective analysis of thermal systems. ML's ability to predict thermal stresses is invaluable in ensuring the safety and longevity of critical components. Renewable energy sources like solar power benefit from ML models that predict solar radiation and energy generation, optimizing energy production and consumption. Cryogenic systems, essential for liquefied natural gas (LNG) plants, are enhanced through ML-driven temperature and pressure predictions, as well as insulation material optimization

The following some of the notable applications
Energy Efficiency Optimization
ML algorithms can optimize the operation of heating, ventilation, and air conditioning (HVAC) systems in buildings. They can learn patterns in energy consumption and adjust system parameters in real-time to minimize energy usage while maintaining comfort levels.

Predictive Maintenance
ML models can predict when components of thermal systems, such as boilers, heat exchangers, or turbines, are likely to fail. By analyzing sensor data, these models can provide early warnings, reducing downtime and maintenance costs.

Load Forecasting
ML algorithms can forecast energy demand, which is crucial for power plants and utility companies. Accurate load forecasting helps in efficient power generation and distribution.

Heat Exchanger Design
ML can assist in the design of heat exchangers by optimizing their geometry and material selection to maximize heat transfer efficiency while minimizing pressure drop and cost.

Thermal Comfort Prediction
ML models can predict thermal comfort levels in indoor spaces based on factors like temperature, humidity, and occupancy. This is useful for designing buildings that provide a comfortable environment.

Combustion Optimization
In industrial processes, ML can optimize combustion systems by adjusting fuel injection rates, air-fuel ratios, and other parameters to maximize efficiency and minimize emissions.

Fluid Flow Simulation
ML can accelerate fluid flow simulations, making it easier to analyze complex thermal systems. Neural networks can learn to predict flow patterns and heat transfer rates, reducing the need for computationally expensive simulations.

Thermal Stress Analysis

ML can predict thermal stresses in materials and components subjected to varying temperatures. This is essential for ensuring the longevity and safety of equipment.

Solar Energy Prediction

ML models can predict solar radiation and energy generation from solar panels. These predictions are valuable for optimizing the deployment and operation of solar energy systems.

Cryogenic Systems

ML can help optimize the design and operation of cryogenic systems, such as liquefied natural gas (LNG) plants, by predicting temperature and pressure profiles and optimizing insulation materials.

Refrigeration Systems

ML can optimize the performance of refrigeration systems by adjusting compressor settings, temperature setpoints, and defrost cycles based on real-time conditions and energy costs.

HVAC Fault Detection

ML algorithms can detect faults in HVAC systems by analyzing sensor data for anomalies. This helps in maintaining system reliability and reducing energy waste.

Heat Recovery Systems

ML can identify opportunities for heat recovery within industrial processes and design systems to capture and reuse waste heat efficiently.

Green Building Design

ML can assist in the design of sustainable, energy-efficient buildings by optimizing insulation, window placement, and HVAC system sizing.

Nuclear Reactor Safety

ML can play a role in predicting and monitoring nuclear reactor conditions to enhance safety and prevent accidents.
In all these applications, ML and ANN techniques can analyze large datasets, model complex nonlinear relationships, and provide valuable insights for improving the efficiency, safety, and performance of thermal engineering systems.

LITERATURE

In recent times the applications of multiphase flow simulation using other techniques such as machine learning and artificial intelligence have increased numerously. One of the common ultimatums in power plants is liquid and vapor in complicated phases where mass, momentum, and energy interact. In this process, FSM (feature similarity measurements) is implemented to predict the data using a coarse mesh. The FSM is preloaded with low and high-fidelity data. Low fidelity data refers to the boundary conditions. The high fidelity data consists of experimental values and values of fine mesh CFD simulation results. The FSM uses DFNN (Direct Feed forward Neural Network), which forms a connection between the nodes and predicts the behavior of liquid and vapor at particular sections. The change in boundary conditions, i.e., low fidelity data, does not affect the results[1]. As the world economy increases, the energy demand also increases. Across the globe, to meet this necessity, nearly 50% of energy production is dependent on coal, and there is an increased concern over carbon footprints. The simulation of coal combustion and the implementation of solid fuel kinetics in CFD uses Large Scale LES (Large Eddy simulation). Though the Large Scale-LES is improved and accurate, the process is not convenient, and the computational cost is high. A machine learning model is implemented along with a database To overcome the computational cost.

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This database consists of detailed kinetic characteristics of single combustion over a vivid range of operating conditions on a novel gas of coal combustion chamber. The model is evaluated using the test database, and this model proves to be an optimistic tool for a computationally efficient model for managing the chemistry of coal combustion. The traditional way (using the LES method), which relies on ODE (ordinary differential equation), consumes more time, and the computational cost is high[2]. In semiconductor industries, an atomic layer deposition method is vastly used because of its high-quality outputs, and the process of atomic layer deposition of silicon oxide consumes more time. A machine learning model is developed using first-principle-based models to overcome this problem. The development process is expensive and time-consuming. A multi scale data-driven model is designed to identify the microscopic process domain dynamics for linear parameter varying models and distinguish the domain film growth. This process is achieved by using the ANN (feed forward artificial neural network). The multi scale data-driven model uses four parameters: precursor feed flow rate, operating pressure, surface heating, and transient film coverage to envision the transient deposition rate. This model can reduce the computational time from 0.6 to 1.2h for every time step, which is essential for the first-principles-based multi scale computational fluid dynamics (CFD) model. This principle made it a real-time feasible process. The prediction outcome for deposition completion time being less than 10%, and the data mismatch did not affect the accuracy, and the cycle continued to work. This eventually reduced the operational cost and time [3]. The safety of the Nuclear Power Plant depends on the study of containment thermal-hydraulics(CTH). Computational fluid dynamics is one of the important approaches to identify the CTH parameters. The cost for computation will be very high for critical models to capture the simulation flow and different values. An alternative method using machine learning is proposed on a coarse grid. This will eradicate the errors and predict the appropriate values for that simulation. The machine learning method is equipped with two other algorithms: Artificial Neural network(ANN) and Random Forest(RF). This is stored with experimental data of fine mesh; based on these values, the algorithms remove the flaws in the coarse grid and forecast sensible results for new cases irrespective of different Reynolds numbers, mesh sizes, and large geometrical models[4]. The thermo physical properties of hybrid fluids such as dynamic viscosity, density, and thermal conductivity largely affect their behaviour in engineering systems. So, to overcome this drawback, few machine learning algorithms have been developed to predict the properties this includes artificial neural networks. Akbar Maleki et al.[2020] comprehensively reviewed several machine learning approaches.

That includes Multilayer perceptron Artificial Neural Network, Adaptive neuro-fuzzy inference system, Radial basis function network, Least square support vector machine, Machine learning-based methods in thermal conductivity modelling, and dynamic viscosity modelling[5]. It is censorious to develop energy-efficient heating, ventilation, and air conditioning systems to maintain a dynamic environmental condition for automotive vehicle cabins. A machine learning model with three algorithms, namely Artificial Neural Network(ANN), Random Forest(RF), Linear Regression with Stochastic Gradient Descent, was included to forecast the Equivalent homogeneous Temperature for every passenger in the cabin. The data for the algorithm is driven from a vehicle cabin CFD model, which is experimented with against the environmental conditions in a wind tunnel with different boundary conditions. The results are satisfying with less than 5% error and providing thermal comfort for different passengers with unique metabolic rates and clothing size or thickness. This also decreased the contemporaneous high-cost CFD simulations[6]. Yaomin Zhao et al.[2020] focused on modifying one of the turbulence models in CFD simulations. They worked on improving the RANS(Reynolds Averaged Navier-Stokes) turbulence model. The conventional RANS model utilizes algebraic methods to analyze the characteristics of flow. The developed RANS model using the machine learning algorithm is implemented on wake mixing regions in the turbo machines. This method was applied to the other three cases with different conditions all results show improvement in the wake prediction[7]. The solar still is a process of purifying saline water. The tubular solar still is one of the types to desalinate the water.

This process is widely applied in geographical locations where the temperatures are high. In this journal, four Machine Learning algorithms Random Forest, Artificial Neural Network, Bayesian Optimization Algorithm for Random Forest, and Bayesian Optimization Algorithm using Artificial Neural Network are implemented to predict the hourly production of water. The experiment is conducted for 16 days and 8 hours each day, making up to 144 hours. During the experiment, it has been noticed that it is workable to forecast the hourly production and efficiency

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of the Random Forest and Artificial Neural Network is improved by 35% by implementing the Bayesian Optimization Algorithm[8]. To analyze the effects on the thermohydraulic performance of heat exchangers, a better machine learning method is introduced to forecast the fluid characteristics in the domain. Generally, large mathematical models are used for this analysis, and this consumes a lot of computational time. To cut computational time, a machine learning method with four predictive algorithms is introduced: random vector functional link, support vector machine, social media optimization, and K-nearest neighbour algorithm. These algorithms include the experimental data for testing. And the experimental data contains inlet and outlet boundary conditions. In the end, the prediction capabilities of outlet temperatures through random vector functional link are compared with the other three algorithms to calculate the mean square errors. The error proves to be minimal[9]. To confront the rigid environmental conditions penned by the European Nations on the production of cleaner energy. The thermal power plants that rely on fossil fuels increase the carbon footprints and nitrogen oxide percentage in the atmosphere. To reduce the nitrogen oxide below 200 mg/m^3, a machine learning algorithm and Artificial Neural Network, and local linear neuro-fuzzy models are equipped to direct urea injection into the firebox in a controlled manner. This resulted in the reduction of nitrogen oxide but increased the greenhouse effects and coal combustion[10]. In recent times, there is increased research in nanofluid heat transfer machine learning algorithms to be applied in renewable energy sources. Many factors influence the characteristics of nanofluids; machine learning methods are used to overcome few problems and give optimum solutions. Firstly, the thermo physical properties of nanofluids are tough to calculate, and to tackle this, an Artificial Neural Network is implemented. This method could give accurate predictions of these properties, including size, shape, density, etc. In renewable energy sources like solar, wind, and geothermal energy, the nanofluids can improve the heat exchanger's efficiency. The performance can be accurately predicted using ANN, ANN-GA, ANN-LINMP. During the suspended period, these nanoparticles form clusters and will be problematic for finding the radioactive properties. A discrete dipole approximation is used to avoid this situation and predict large clusters' particle size and shape. Machine learning models like ANNs and ANN-based hybrid approaches can give exact values for the performance of nanofluid in solar energy, which is responsible for high thermal conductivity and optical characteristics. The ANN algorithm does not always give the exact values, so this is integrated with other intelligent algorithms like PSO, SA, and AC to improve the predictions. On the other hand, Ting Ma et al.[2020] discussed the contradictions of the ANN in nanofluid heat conductivity[11].

A conservative method is used for thermal conductivity modelling, which depends on the theoretical framework, which controls the microstructural evolution during the neutron irradiation. A similar method is developed using deep neural network algorithms that do not rely on previous information about the material microstructural system to predict the thermal conductivity on different operating and material conditions. A study is conducted on uranium molybdenum fuels, and irradiation test data is held to develop this model. The work represents the possibilities and restrictions in the field of materials science and material property modelling[12]. The study concentrates on the flow boiling/condensation in mini channel offset fins. An experiment is conducted on R134 refrigerant, and the data driven from this experiment is used to build an Artificial Neural Network for analyzing the heat transfer coefficient. This model forecasted a mean absolute relative deviation of 11.4% and 6.06% for boiling and condensation. The different dimensionless conditions have different influences on heat transfer coefficient; the ANN-based model gave sensible accurate results. The data obtained through an improved ANN model could be transferred to different datasheets for the same domain, but this could give a poor performance while transferring the datasheet[13]. Two important developments are made by introducing porous foam in an internal combustion engine. This reduced the carbon footprints and also increased thermal efficiency. These values are obtained through SOPHT software, which is used for modelling the porous foam internal combustion. The SOPHT uses large-scale differential equations for thermal circuits in the engine. With the recovered heat from the exhaust gas, less fuel is used, and this also oxidizes the unburnt particles in the chamber[14]. A study is conducted based on the machine learning program to reduce the pollutants from the CI-Engines. The program used other algorithms like Deep Learning, Artificial Neural Network, Support Vector Machine, and K-Nearest Neighbour. Nano particles with good oxygen contents are injected directly into combustion chambers, which helps complete fuel combustion.

Further, the experiment focused on carbon dioxide (CO), nitrogen oxide (NOx), exhaust gas temperature (EGT), brake specific fuel consumption (BSFC), and brake thermal efficiency (BTE). This experiment is carried on different engine speeds between 1500 and 3400 rotations per minute with uniform intervals of 100 rpm. The results for neat diesel fuel show the reduction in NOx is found to be 3.28, 7.53, and 10.05%, and the reduction in CO is found to be 8.3, 11.6, and 15.5% for TiO2, Al2O3, and CuO test fuels, respectively [15]. Using numerical methods may not give accurate thermal transport mechanism simulations results due to the lack of physical resources. A machine learning-based algorithm is developed to predict the structural effects of thermal transport in porous media. The ML is equipped with all the necessary physical properties and boundary conditions, predicting accurate results. A piece of comprehensive knowledge is required in thermal transport mechanisms for different engineering and industrial applications[16]. It is necessarily better to understand the thermal conductivity of amorphous coal ash to design a gasification system. A machine learning model uses Artificial Neural Network, Random Forest, and other techniques to forecast accurate results based on the available experimental data. These techniques have found that higher amounts of CaO and lower volume of silicon dioxide and aluminium oxide have high thermal conductivity during the process. In conclusion, this journal provides effective policies for thermal conductivity prediction of amorphous CSA ternary systems and the mechanism research.[17]. A machine learning model with a self-adaptive differential evolution algorithm is proposed to analyze the 2-Butanone reduced mechanism. This mechanism contains certain characteristic features that include 50 species and 190 reactions for the first time. These are initially divided into three parts based on their chemical parameters, and in the next step, a set of 31 reactions are optimized using algorithms. This algorithm predicts the ignition delay times and laminar flame speeds of 2- butanone. This model could be used to find out the solution for global problems[18].It is hard to find the exact thermal conductivity of material for both experimental and theoretical ways. In general, there is a method to evaluate the conductivity. An alternative method is initiated using a machine learning algorithm to determine the intermolecular potentials using the first-principles estimation of thermal conductivity. The major obstacle is to find a method to acquire the an harmonic interatomic force constants using computationally demanding DFT calculations. Numerous data is driven from various experiments and two-dimensional simulations. This process could be utilized as a standard tool for predicting lattice thermal conductivity compared to the commonly used full-DFT solution[19]. In civil industries, it is important to know the thermal conductivity of the concrete structure. The thermal conductivity of each structure is unique, and to evaluate the thermal conductivity of every structure a machine learning method is developed with a data-driven model. This method showed the temperature gradient and provided the concrete mixing data for different structures. This model could be improved by using a large training dataset[20].

In the steel plate producing industries, the process parameters and steel grade composition significantly affect steel production's micro structural and mechanical properties. It is difficult to identify the exact composition to maintain these properties to meet the industrial standards in traditional ways. A deep neural network method is designed to predict the parameters and properties of steel plate industries. This algorithm is formulated in a pattern that takes 27 input parameters, two hidden layers, 200 nodal points, and four output parameters. In other words, these can also be termed as initial conditions. This process will give the steel plate mechanical properties that include yield strength, ultimate tensile strength, elongation, and impact energy. This modified Dynamic Neural Network has a root mean square error of 21.06 MPa, 16.67MPa, and root means square percentage error of 4.7%, 2.9%, 7.7%, and 16.2%, for yield strength, ultimate tensile strength, elongation and impact energy, respectively. This DNN method is the most efficient and accurate compared to other online services. This method helps maintain the exact mechanical properties and guides the worker to change the composition to get the desired outputs [21]. Arun C. Ravindran et al.[2021] worked on the reduction of computational time for simulating an Internal Combustion engine using a machine learning method. Among the different IC Engine solvers, the Gaussian Progress Regression is the most used method. In this process, computational modelling with the GPR solver-based machine learning technique is developed. The model consists of a cold start fast idle phase of gasoline direct injection spark ignition (GISI).

The process considers the following parameters to clinch the cold start condition. (1) A fixed IMEP of 2 bar (BMEP of 0 bar), (2) A stoichiometric exhaust equivalence ratio (based on carbon-oxygen atoms), (3) adequate exhaust heat flux to ensure a rapid light-off of the after-treatment system, and lastly (4) decreased NOx and HC emissions. These

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parameters are considered to have a greater impact on the cold start engine performance. The parameters mentioned above are linked to the fuel injection, combustion procedure and intake airflow. Running the multiple cycles in any conventional CFD software would be difficult, and it will take a long time. To attain the results mentioned above, IMEP (Indicated Mean Effective Pressure) of 2 bars could be made easy and reduced time using the GPR-ML algorithm. Normally, the 3D-CFD would take no less than six days, and this algorithm could complete the case in a few minutes[22]. Han Bao et al.[2020] developed Feature Similar Measurement(FSM) technique to identify the errors in two-phase flow simulation using coarse mesh. This FSM captures the coarse mesh errors and uses the physics-guided data-driven method to achieve a comparable accuracy as fine mesh simulation with fast-running features. High-fidelity data and low-fidelity data are used to identify the underlying information relevant to the main simulation errors and the effect of phenomenological scaling. Using the previous simulation data, an alternate model called Deep Feed Forward Neural Network was trained and developed. In this process the two phases of bubbly flow method is developed to measure the unphysical "peaks" in the velocity and void fraction profiles near the wall in the coarse-mesh configuration ny Han Bao et al.[2020]. This physics-guided method in coarse mesh-CFD simulations plays a significant role in industrial designs[23]. The zinc chloride ($ZnCl_2$) and other alkali chlorides are convenient thermal storage and heat transfer fluid materials in the future generation of concentrated solar thermal power Gechuanqi Pan et. al [2020]. Understanding the cavernous properties of the $ZnCl_2$ is necessary to maximize the thermal storage and high-order mixture. The microstructure information and the thermodynamic properties of the materials are to be recognized. This is the first time an intermolecular potential of $ZnCl_2$ based on neural network machine learning is developed. The technique uses partial radial distribution function, coordination number, and partial structure factors with AMID and PIM potential. In the end, this method provides detailed information on the microstructures than the PIM potential, which suffers from the analytical form. This method will give an accurate molecular simulation of structures and dynamics of molten $ZnCl_2$ mixtures [24]. To solve a conductive heat transfer partial differential equation that uses convective heat partial differential equation as boundary conditions in the manufacturing process, a physics-informed neural network is developed. The conventional trial and error finite element simulations are very slow. The prognosis of one-D and two-D are validated by comparing with Finite Element results. In conclusion, only by using physics-informed activation functions, the heat transfer beyond the training zone can be accurately predicted. These models were successfully tested and used for real-time evaluation of thermal responses of parts subjected to a wide range of convective boundary conditions only [25].

Searching for new material is important to meet the growing industrial needs and decrease the increasing pollution. Pollution can also occur through the improper handling of E-waste and other waste. To overcome these problems, research institutes and government bodies invest heavily in finding new materials. The conventional method uses a trial and error mechanism, which consumes a lot of time. It is not easy to process; this process has been made easy after introducing the big-data era. Then a Machine-Learning based algorithm is developed that takes the frequently used data are classified and compared. The current applications of this is seen in metal materials, battery materials, and metallic glass are reviewed [26]. The cities are expanding, and the buildings are constructed closer to meet the increasing population. Due to this, air circulation becomes slower. This inferiority could be enhanced by making good urban planning and building design. On the other hand, indoor natural ventilation requirements in current building standards only define absolute indoor airspeed without considering the outdoor parameters. A Machine-Learning algorithm is designed based on the 3,480 computational fluid dynamic simulations to tackle this situation, and this method is called Gradient Booster. This model showed an improved building design correlation of $R^2(0.2)$ compared to other linear regression models [27]. The present thermal-hydraulic system of simulation is restricted to its best performance even in the real-time industrial works for testing large scale geometries and boundary conditions. This is due to the size of the mesh, the mesh induced error, and the model error is connected. This makes it difficult to estimate the model scalability independently. Han Bao et al.[2020] used a Machine-Learning data-driven technique to build a Similar Feature Measurement to eradicate these problems.

A set of physical features that embody the information from a set of physical systems of interest, empirical correlations, and the effect of mesh size are taken into consideration and simulated the parameters. At the end of the simulation, an error database is constructed using the deep learning method. With the help of the deep learning

technique, the relation between physical error and simulation errors are estimated. This helps in predicting even the large scale gaps in the grids [28]. It is laborious to guess the performance of a base cycle power plant. Predicting the malfunctions of materials in a prompt period is an arduous task that depends on complex thermodynamics. Here, many Machine-Learning methods are used to test the performance and identify all the abnormal activities of a combined cycle power plant of five years of recorded data. A modelled total load power output of the plant using ambient pressure, atmospheric temperature, relative humidity, and exhaust vacuum pressure these parameters are used as the input features for a combined Machine-Learning method that includes linear regression, support vector machines, random forest, and artificial neural network. The obtained through all the techniques turned out to be accurate with greater than 92%. This method drives data through the small sensors and gives detailed information that is incomprehensible to humans and becoming a potential game-changer monitoring health [29]. Four powerful Machine-Learning methods, namely, the ordinary kriging method, adaptive neuro-fuzzy interference system, a multilayer artificial neural network, and a Hybrid of Fuzzy logic and Genetic Algorithm along with thermodynamics based approach of Van der Waals - Platteeuw are confronted for CO2 gas hydrate formed in the presence of thermodynamic promoters as well as for semi-clathrates formed from CO2. The methods are collated together because of their potentials in capturing CO2, which are computationally challenging and time-consuming. To estimate the equilibrium, correlation coefficient, minimum and maximum errors are included for testing. The artificial neural fuzzy interference system estimated the accurate values with the highest accuracy among all four methods. This method could be used as the alternative to the traditional van der Waals-Platteeuw method and can be easily coupled with industrial, commercial software to reduce calculation times while maintaining accuracy[30]. Bin Xu et al.[2020] constructed a herculean method for the real-time realization of the Dynamic Programming algorithm for streamlining the Organic Rankine Cycle waste heat recovery system. For the first time the Machine-Learning algorithm, single state proper orthogonal decomposition, and Galerkin projection-based reduced order models are combined with the Dynamic Programming to optimise the power generation, extracting rules through offline and this provides high accuracy with low computational cost. In this method, a total of 11 Machine-Learning algorithms are selected for this study and Random Forest is selected for its better performance in forecasting the accurate pump speed. This method can be conducted using steady-state and transient conditions, and the results do not hold the same for both cases. The problem for the low accuracy is time in exhaust gas mass flow rate and exhaust temperature. This study found that the Random Forest model accuracy is improved by including a rule-based method. By adding the rule-based method, the prediction is increased from 66.5% to 97.2%. This process can be applied for extracting Dynamic Programming rules in real-time application due to its high accuracy [31].

The machine-Learning method with dingle-hidden layer feed forward neural networks (SLFN) process is applied to alter the SI-Engine that uses octane as fuel. With five different engine speeds ranging between 1000 to 3000rpm, crankshaft angle from -360 degrees to 360 degrees without exhaust gas being recirculated. The extreme learning machine can identify the combustion parameters used to bounce the pressure information for the entire cycle in a single-cylinder compression ignition engine. ELM method solves the mathematical models faster, and the hidden layers of the SLFN's need not be changed for each simulation. It is necessary to set up the initial condition like velocity, simplicity, accuracy, and the appropriate node to initiate it. An experimental data sheet is used to train the ELM models and compare two case studies based on performance criteria related to accuracy, sparsity and complexity. In conclusion, the results showed that the proposed model could predict the mean effective pressure in agreeable regularity using the experimental results[32]. Estimating the residual life of an aircraft turbine engine plays an important role in assuring aircraft safety. Yet, several types of research are conducted on estimating the turbine engines' life, and some are based on ensemble learning methods. Jiyan Zeng et al.[2020] Introduced an ensemble Machine-Learning based methods to calculate the outstanding life of the air-craft. These Machine-Learning methods {Stacked Autoencoder(SAE), Convolution Neural Network(CNN), & Long Short-Term Memory (LSTM)} considers the euclidean distance weight of the air-craft turbine engine for calculations. The weight of each member algorithm is allotted based on the Euclidean distance between the predicted and real Remaining helpful Life.

A group of datasets is provided for the RUL simulation obtained from the aero-propulsion simulator C-MAPSS. This method surpasses other member algorithms [33]. To find out the defects in two-wheelers using an upgraded version

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of Convolution Neural Network(CNN). This method begins with the acquisition of vibration data, and next, time-domain signals are transformed to the angular domain. Later, random distribution of angular domain signals is done to set training and test data. A set of time-frequency images are generated using the wavelet synchro-squeezed technique. These images are used to tailor the CNN method to improve CNN model in identifying the flaws in the internal combustion engine of two-wheeler vehicles[34]. It is always a difficult task to find the characteristics of gasoline direct-injection engines. The air-fuel mixture and nozzle sprays are responsible for combustion and emission characteristics. Although several spray models and computational fluid dynamics simulations are tested to identify the air-fuel mixture, these simulations are restricted only to single axial-nozzle injectors and a limited range of ambient conditions. A sequence of spray experiments is conducted in a constant-flow spray vessel coupled with high-speed diffused back-illumination extinction imaging to generate a data set for algorithm training. Different fuels are tested, such as iso-octane(ic8) and multi-component EEE gasoline, which cover a wide range of fuel properties were injected using Engine Combustion Network (ECN) Spray G injector under ECN G2 (50 kPa absolute), G3 (100 kPa absolute), and G3HT (G3 with 393 K ambient temperature) conditions. The Machine-Learning algorithm includes IC8IB2 (IC8 80%, Iso-Butanol 20% v/v) and EEE gasoline are termed as the target fuels from the above mentioned fuels to predict the spray. This method is capable of estimating the spray 3D topology for various fuels and ambient conditions. This system represented a consistent tendency in experimental data showing slight rise in the movement for IC8IB2 despite complete spray collapsing EEE gasoline fuel. This Machine-Learning algorithm is capable of forecasting spray performance, and it is better than CFD simulation [35].Knowing the mechanical properties of any composite mixture or material is always helpful. But it could be hard to calculate these properties. Similarly, finding the properties of cement composite takes more time and laborious using the conventional model. A predictive model is designed and trained using the experimental data. The sensitivity analysis indicates that having the maximum influence on compressive strength is the length of CNTs, whereas having the maximum influence on flexural strength is the curing temperature. The results show that this Machine-Learning model predicts more accurate values than the other regression methods[36]. An algorithm is structured to study the large scale discretized physical system's relevant variables and estimate its time evolution using thermodynamically consistent deep neural networks. This method initially depends on a sparse autoencoder, which decreases the dimensionality of the full order model to a set of sparse latent variables with no preliminary understanding of the coded space dimensionality. Later, a second neural network is trained to learn the metriplectic structure of those reduced physical variables and forecast the time required with a structure-preserving neural network. This data set promises to conserve the total energy of the system and the entropy inequality[37].

A Machine-Learning based Bayesian approach is designed to decrease and indirect measuring of unpredict abilities in multiphase fluid dynamics simulations for bubbly flows. High-resolution two-phase flow measurements with double-sensor conductivity probes, high-speed imaging, and particle image velocimetry are included in this process. To support the Bayesian inference, the local distributions of key physical quantities of interest (Qols) combine the void fraction and phasic velocities. This process includes three types of machine-Learning methods: Feed forward neural network, principal component analysis for surrogate modelling, and Gaussian process for model form uncertainty modelling. In this entire procedure, an open-source deep-learning library, PyTorch, with graphical processing is used to ensure the efficiency of the computation. In this method, a group of uncertainties is passed through the multiphase computational fluid dynamics solver to acquire the unpredict abilities from the Qols and validate these qualms; a probability box is developed. With the help of the high-resolution data, the qualms of the MCFD are reduced[38]. In present days, nanofluids are widely used for several engineering and industrial purposes that include heat exchangers, nuclear power plants, and air-conditioning. These are few areas where the nanofluids are currently being used. This study identifies the Nusselt number by including the Prandtl number, volumetric concentration, and helical number of the helically coiled heat exchanger as input data.

Seventy-two experiments are conducted on a group of Machine-Learning models, a multilayer perceptron artificial neural network (MLP-ANN), adaptive neuro-fuzzy inference system (ANFIS), and Least squares support vector machine (LSSVM) out of them LSSVM approach showed the best performed [39]. The main aim of this work is to reclaim the data at any time instance. The data input-output constitutes a remarkable constriction in large-scale CFD

simulations. Thus, a user would like to significantly reduce the number of times the solution is saved to disk yet retain the ability to recover any field quantity. In this process, a high-order discretization is considered with two-stage methodology:1) dimensionality reduction and 2) dynamics learning. In dimensionality reduction, firstly, it decreases the number of degrees of freedom using auto encoders from deep learning. Secondly, it applies an analysis to compress the global vector of encodings. A regression technique is appertain to study the discrete-time velocity characterizing the time growth of low-dimensional state in dynamics learning. An example of CFD simulation with 13 million degrees of freedom demonstrates an appropriate method for an industrial setting[40].

CONCLUSIONS

The application of Artificial Intelligence (AI) and Machine Learning (ML) in thermal engineering has ushered in a new era of innovation and efficiency in the field. There are several key points:

Improved Energy Efficiency AI and ML algorithms have demonstrated their effectiveness in optimizing the operation of thermal systems, such as HVAC and industrial processes.

Predictive Maintenance ML models empower thermal engineers to transition from reactive to proactive maintenance strategies

Enhanced Sustainability The optimization capabilities of AI and ML contribute significantly to sustainability efforts.

Design and Simulation ML-powered simulations and design optimizations streamline the development process of thermal systems.

Safety and Reliability Predictive capabilities of AI and ML extend to thermal stress analysis and nuclear reactor safety.

Real-time Monitoring and Fault Detection ML-driven fault detection systems enhance the reliability of thermal systems by identifying anomalies and issues as they occur.

Resource Optimization AI and ML contribute to resource optimization in thermal engineering, as they help allocate resources like energy, materials, and labor more efficiently, thereby reducing waste and costs.

Data-Driven Decision Making The wealth of data generated by thermal systems is harnessed for informed decision-making. AI and ML enable engineers to extract valuable insights from data, leading to more effective strategies and system improvements.

Challenges Remain Despite the significant progress, challenges like data quality, model interpretability, and integration with legacy systems persist. The application of AI and ML in thermal engineering has brought about transformative changes, resulting in enhanced energy efficiency, sustainability, reliability, and safety. As these technologies continue to evolve and integrate with traditional thermal engineering practices, they hold the potential to reshape the industry, making it more efficient and environmentally friendly. Continued research, development, and collaboration between experts in thermal engineering and AI/ML practitioners are essential to further unlock the benefits of these technologies in this field.

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RESEARCH ARTICLE

Application of Electrical Resistivity Method (ERM) In Groundwater Exploration in Bandalli Watershed, Chamarajanagar District, Karnataka, India

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ABSTRACT

The geophysical method which is dominant by geophysicists become one of the most popular methods applied by Geological surveys. Electrical Resistivity Method (ERM) is one of the geophysical tools that offer a very attractive technique for subsurface profile characterization in larger areas. Applicable alternative techniques in groundwater exploration such as ERM which complement the existing conventional method may produce comprehensive and convincing output thus effective in terms of cost, time, data coverage, and sustainability. ERM has been applied in various applications in groundwater exploration. This review paper was carried out to expose the application of ERM in groundwater exploration. The result from ERM could be additional information to respective experts for their problem solving such as the information on groundwater pollution, leachate, underground, and source of water supply. Vertical Electrical Sounding (VES) using a Schlumberger array was carried out perpendicular to the ground in the Bandalli watershed to study the subsurface geological formation and delineation of freshwater aquifers at fifteen (15) VES stations. The field data obtained have been analyzed using computer software (IPI2WIN) which gives an automatic interpretation of the apparent resistivity. Lithology and Soil data were used to integrate the results. The geologic sequence beneath the study area is composed of topsoil, weathered layer, and clayey mixed as well as rocky land. The IPI2WIN program is a tool created to automatically or semi-automatically evaluate data from 1D geo-electric measurements on a single piece to determine the inaccuracy with the least possible margin.

Keywords: Vertical Electrical Sounding (VES), IPI2win Program, Bandalli watershed, Schlumberger array, Aquifer.

INTRODUCTION

s Water is a renewable resource that occurs in three forms liquid, solid, and gaseous. The groundwater is essential for irrigation, industry, and domestic purpose. Groundwater is the main source of potable water supply, for domestic, industrial, and agricultural uses. Groundwater is becoming more and more scarce as a result of urbanisation, growing populations, industrial and agricultural activity, natural disasters, etc. Any activity related to human life can benefit greatly from an understanding of groundwater geology. Compared to surface water, groundwater has more advantages. The water scarcity problem affects the human chain and other living things. To meet the water demand, people are depending more on aquifers. There are two end members in the spectrum of types of aquifers; confined and unconfined (with semi-confined aquifer being in between them) (Ogungbel A.S, 2010). For identifying the groundwater potential in the hard rock aquifer terrain the main target is the fractured zone. The present study focuses on the identification of the fracture zone and its thickness by using the geoelectrical resistivity method. With the advent of powerful and high-speed computers, efficient techniques for groundwater exploration and management have evolved, of which remote sensing and GIS are of great significance (Chowdhury et.al., 2009). The global world is currently confronting a significant problem in the form of securing water for sustainable development. At present, developing countries face environmental pressure induced by high-population communities, rapid urbanization, and deficient water sector services reflecting improper management of water resources (UN, 2003; WHO, 2006). Groundwater aquifer salinization is a problem that affects coastal regions because excessive groundwater well pumping from unrestrained coastal aquifers causes seawater intrusion. Many places throughout the world have documented this harmful consequence of human activity. Hence, this problem is likely to arise in areas like the Bandalli watershed that have poor water resources (low precipitation and high evaporation) and has mismanagement of water resources (Abu Heen *et al*., 2008; Abu Mayla *et al*., 2010). Bandalli watershed is classified as a semi-arid region and suffers from water scarcity. Groundwater is the main source of water in the Bandalli watershed. Water analysis results revealed that more than 90% of the water wells are unsuitable for domestic use according to WHO standards. The water sector suffers a lot of problems in terms of quantity and quality (Abu El-Naeem *et al*., 2009). The Bandalli watershed water supplies are stable or even declining as a result of urban expansion, but water demand is rising continuously due to economic growth, population growth brought on by natural growth, and returnees. (Hamdan, 2006). DC surface resistivity methods have been used for groundwater research for many years. It can be used to map the freshwater-saltwater interface and for studying conductive bodies of hydrogeological interest (Keller and Frischknecht, 1966; Zohdy *et al*., 1974; Batayneh *et al*., 2010; Chitea *et al*., 2011; Satriani *et al*., 2011; AL-Khersan,2012; Olympia *et al*., 2013; Thabit *et al*., 2014; Basheer *et al*., 2014; Kalisperi *et al*., 2015).

MATERIALS AND METHODS

Study Area
Bandalli watershed is roughly in the southwestern part of the Hanur taluk and Chamarajanagar District, Karnataka. It comes under the Survey of India toposheet numbers 57H/4 and 57H/8 on a scale of 1:50,000. The geographical study area falls into the Archean-Proterozoic gneiss of southern Karnataka state between 12°09'56.3" North latitude and 77°21'06.5" East longitude (Fig.1). The lithology of the study area is underlain by hard rock terrain consisting of Peninsular gneiss, Charnockite, Epidote/Hornblende Gneiss, Migmatites & Granodiorite and Pink granulite (Fig.2). Soil types and texture are the preliminary role of infiltration and transmission of surface water into a subsurface of aquifer system (Fig.3). The Relief ranges from 290m to 700m above MSL. The minimum and maximum temperature ranges between 20°C to 36°C in the month of January and May respectively.

Geophysical prospecting of groundwater comes under both surface and subsurface exploration. Under geophysical prospecting, one of the electrical methods is the Schlumberger array of electrical resistivity methods. The Schlumberger array was used to ensure deep penetration and for logistics of limited manpower in the field.

Schlumberger configuration using processor-based signal stacking digital resistivity meter of CRM 20 model of Aquameter. Both the survey procedures resistivity profiling and resistivity sounding (VES) have been carried out. Resistivity profiling has been conducted in a grid pattern. The total study area of 100 Sq.km. has been divided into square grids of 2.0 Sq.km and 6 resistivity profiles were conducted with a station interval of 2 Km. Resistivity profiling with AB/2 10, 20, 30, 40, 50, 60, 70, 80, 90& 100 m has been carried out. VES has been conducted at 15 locations and the resistivity data have been qualitatively and quantitatively interpreted and analyzed by IPI2WIN software packages.

Measurement of Resistivity

In general for measuring the resistivity of the subsurface formation four electrodes are required. The current of electrical intensity (I) is introduced between one pair of electrodes called current electrodes, which can be identified as A & B. The potential difference produced as a result of current flow is measured with the help of another pair of electrodes called potential electrodes represented as M&N. Let's represent the potential difference. The apparent resistivity measure is K*Dv/I, where K represents the geometrical constant, which can be calculated if we know the electrode arrangements. The basic needs for the resistivity survey are the power source, meter to measure current and potential, electrodes, and cables. Resistivity of the ground is measured by injecting direct currents or very low frequency alternating current into the earth through pair of electrodes and the measuring resulting potential differences between another pair of electrodes at a multiplicity of locations at the surface. These measurements are inverted into a distribution of electrical resistivity in the subsurface. Ohm's law serves as the basis for the interpretation of resistivity boundaries in terms of lithological boundaries. The current flow radially out from the current source in a homogeneous ground (half space), and the resulting equipotential surfaces run perpendicular to the current flow lines, forming half spheres. The equipotential surfaces and current flow lines get more complex in the typical scenario including both a current sink and a current source (Kirsch, 2009). Geoelectrical data are commonly expressed as apparent resistivity and given by the equation: $\varrho a = K (\Delta V/I)$. Where ΔV is the measured potential, I is the transmitted current, and K is the geometrical factor. Many electrode configurations have been proposed for electrical resistivity surveys. The kind of structure to be mapped, the resistivity meter's sensitivity, and the amount of background noise all influence which array is appropriate for a field survey. In practice in a 1-D sounding survey, the arrays that are most commonly used for hydrogeology surveys are the Schlumberger and Wenner arrays (Dahlinand Zhou, 2004; Loke, 2011). A vertical electrical sounding survey (VES) is used to determine the resistivity variation with depth. It's common in geoelectrical hydrogeological studies to use the ohm resistivity meter as a field instrument and the Schlumberger configuration as a ground electrode array.

Schlumberger Configuration

In Schlumberger configuration, all four electrodes are kept in a line similar to that of Wenner but the outer electrode spacing is kept large compared to inner electrode spacing usually more than five times. For each measurement, only the current electrodes are moved to keep the potential electrodes at the same locations. The potential electrodes are moved only when the signal becomes too weak to be measured. The apparent resistivity for this configuration is computed with the formula; $\varrho = \{[(AB/2)2 - (MN/2)2)/MN]* \pi R\}$, (Keller, 1966). Vertical electrical sounding (VES) with Schlumberger array as a low-cost technique and veritable tool in groundwater exploration is more suitable for Hydrogeological survey of the sedimentary basin (Nejad *et al.*, 2011; Egbai, 2011; Adeoti *et al.*, 2010). The main goals of the work are to determine the subsurface aquifer layers' thickness and Resistivities of the Bandalli watershed.

Resistivity and Thickness

The resistivity of the first layer of topsoil ranges from 20 to 60Ωm as observed, with low resistivity to indicate sand saturated with water. A good conductive low resistivity range indicates the presence of rocks (Fig.5). A second layer with resistivity values of 1200 to 3600 Ωm was observed in the above high resistivity zones, low resistivity zones (Fig.6). A third layer with resistivity values from <150 to >450 are seen in the (Fig.7). In Fig.8, 9, 10. it can be seen that with a thickness low resistivity values from less than 4 to greater than 8 occurs in almost all the areas covered.

RESULTS AND DISCUSSION

To determine the resistivity values of various subsurface layers and their related thickness, partial curve matching techniques and computers were used to evaluate and process the field data in both a qualitative and quantitative manner. Table 1 is several results of VES data interpretations with classifications of groundwater types.

CONCLUSION

Vertical Electrical Sounding using Schlumberger electrode configuration was conducted in and around Bandalli watershed to determine the underground water potential and the lithological setting in terms of aquifer distribution. The study has shown that the region is underlain by 2 to 3 geoelectric layers within the depth penetrated. The groundwater potential in and around the Bandalli watershed (Table 1) reveals three distinct classes (zones) representing 'Very good', 'good', and 'Moderate' groundwater potential in the area. The Very good groundwater potential zone mainly encompasses good recharged along the River alluvium.

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Conflict of Interest
There are no conflicts of interest among the authors.

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Table.1: Results of VES data interpretations with the classification of groundwater types of the Bandalli Watershed.

Sl. no	Name of the locations	Thickness layer			Resistivity			Description of layer	Classification
		h_1	h_2	h_3	ϱ_1	ϱ_2	ϱ_3		
1	Budabalu	2.5	2.2	4.05	85	43.7	155	Silt-clay	Aquiclude
2	Halagapura	4.22	0.36	2.96	78.7	68.3	226	Hornblende gneiss	Aquifuge
3	Hanur	5.79	2.85	28.6	54.1	1232	161	Sand and gravel	Aquifer
4	Mangala	2.5	7.14	20.2	0.27	1408	184	Sand and gravel	Aquifer
5	Bandalli	3.71	1.07	2.65	77.5	105	194	Silt-clay	Aquiclude
6	Managalli	3.22	0.97	4	71.9	267	183	Silt-clay	Aquiclude
7	Kamagere	2.5	7.14	20.2	0.305	1441	188	Sand and gravel	Aquifer
8	Chinchalli	2.5	7.14	20.2	0.32	1722	224.8	Pink granulite	Aquifuge
9	Banur	8.87	0.77	20.2	24	3318	4414	Charnockite	Aquifuge
10	Ikkadahalli	8.87	0.71	20.1	0.983	4705	614	Clay mixed	Aquiclude
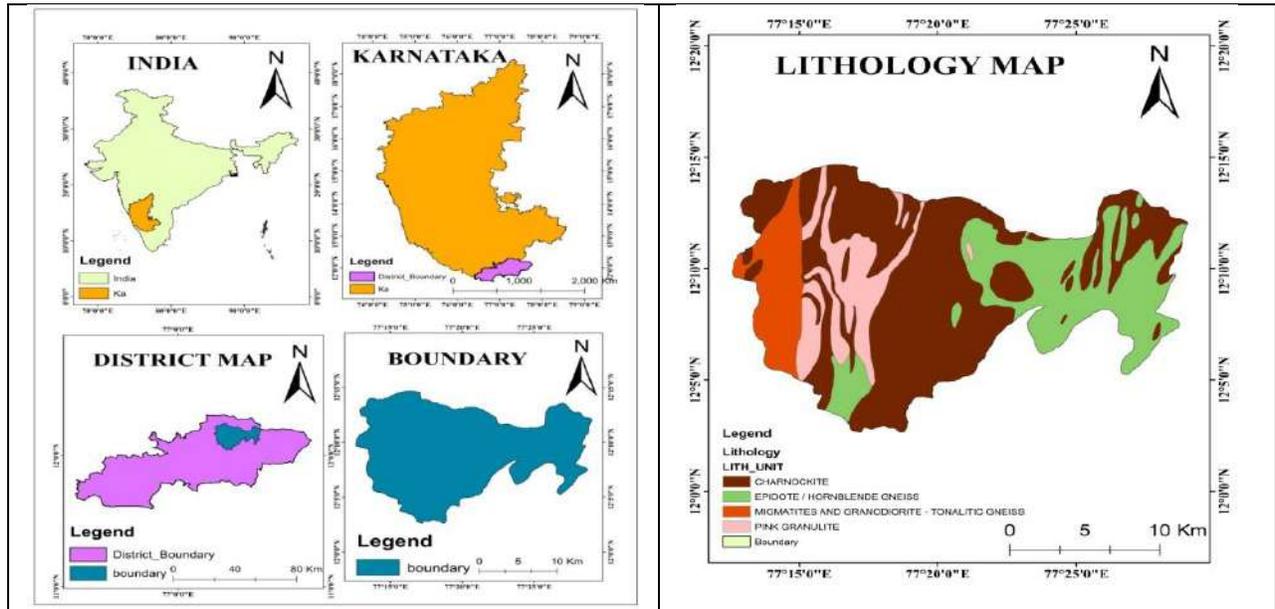
Fig.1 Location map of the study area

Fig.2 Lithology of the study area
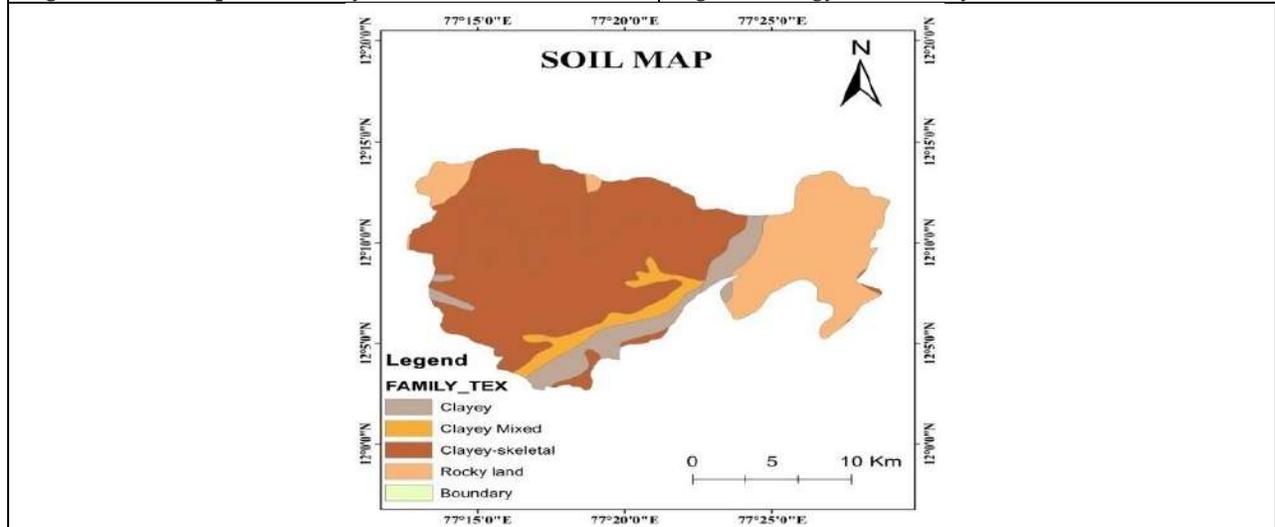
Fig.3 Soil map of the study area
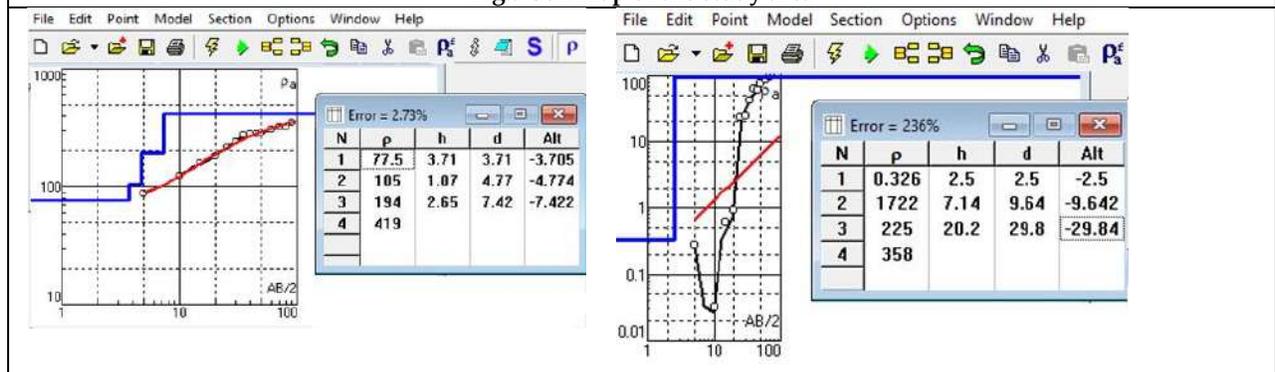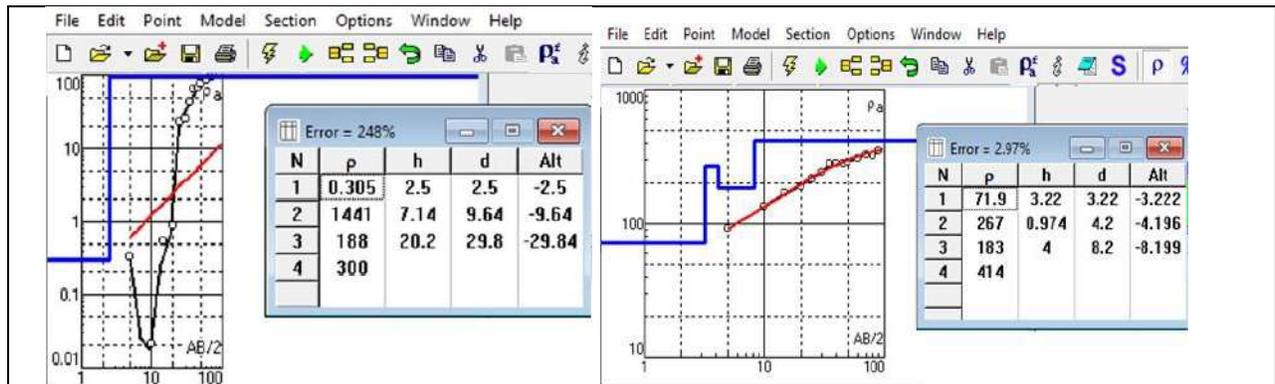
Fig.4: Interpretation of VES field curves of the Bandalli watershed.
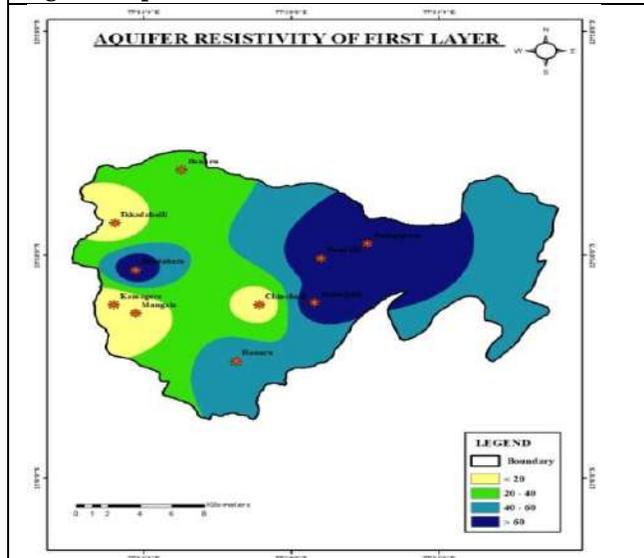
Fig.5. Aquifer resistivity of first layer
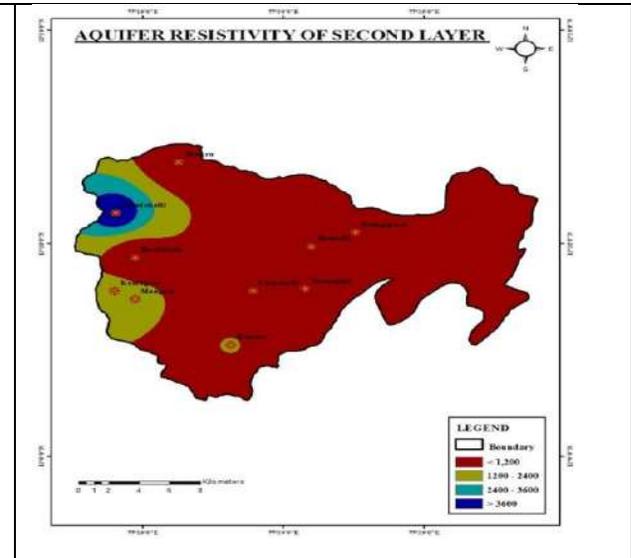
Fig.6. Aquifer resistivity of second layer
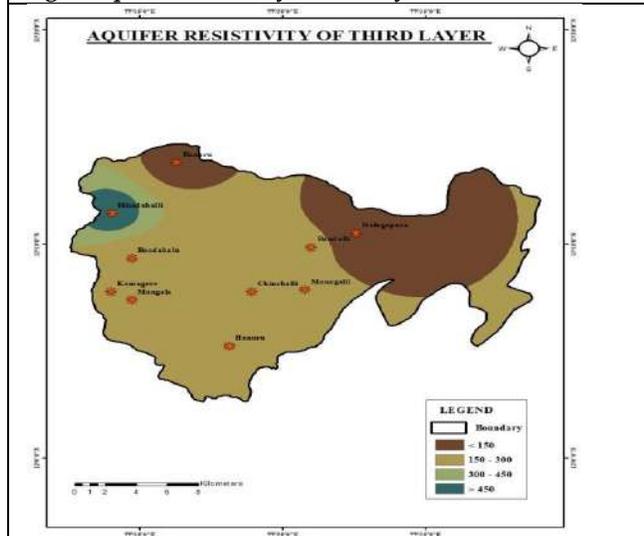
Fig.7. Aquifer resistivity of the third layer
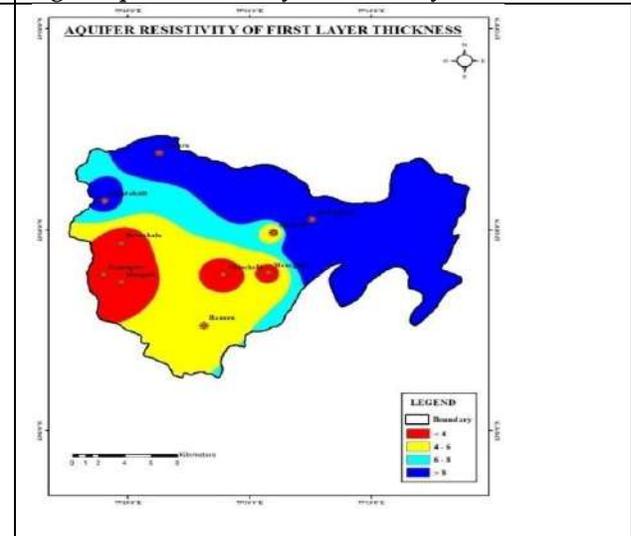
Fig.8. Aquifer resistivity of first layer thickness

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Fig.9. Aquifer resistivity of second layer thickness	**Fig.10. Aquifer resistivity of third layer thickness**

RESEARCH ARTICLE

Effect of Resistance Training on Increasing Explosive Strength in Adolescent Basket Ball Players

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ABSTRACT

This study examined the effects of a 10-week in-session resistance training program on the explosive strength of adolescent male basketball players aged 14 to 17. The participants were divided into two groups: one group underwent the resistance training program in addition to their regular basketball practice, while the other group continued with their standard basketball training. The results indicated significant improvements in both vertical jump height and Medicine ball throw distance among the participants who completed the resistance training program. These improvements are critical in the context of basketball, as they directly impact a player's ability to jump, accelerate, and generate explosive force during the game. Notably, the resistance training program did not place excessive stress on the skeletal muscle development of the adolescent athletes. This finding is particularly important, as it ensures that the training regimen is both effective and safe for young athletes. In summary, incorporating a well-structured resistance training program into the training routine of adolescent male basketball players can lead to significant enhancements in explosive strength, which is vital for improved basketball performance. This study provides valuable insights for coaches and trainers working with young basketball athletes, highlighting the potential benefits of including resistance training in their training protocols.

INTRODUCTION

In the realm of athletic performance, the pursuit of excellence is a relentless endeavor, especially for adolescent athletes aspiring to elevate their game to the highest level. Among these young athletes, basketball, with its dynamic blend of sprinting, jumping, and quick directional changes, stands out as an immensely demanding sport[1]. The efficacy of training methods in enhancing athletic performance has long been a subject of intrigue, and one aspect that has garnered significant attention is the development of explosive strength. This crucial attribute, defined by the ability to generate rapid, forceful muscle contractions, plays a pivotal role in an athlete's capacity to outmaneuver opponents, dominate the court, and excel in various aspects of the game[2]. In the context of adolescent basketball players, the quest to improve explosive strength takes on particular significance. This period of physiological development represents a critical juncture in an athlete's journey, where the right training interventions can have a profound and lasting impact on their athletic potential. The incorporation of resistance training into the regimen of these young athletes has been a topic of growing interest and debate among coaches, trainers, and researchers[3, 4].

The question at the heart of this discussion is whether resistance training, designed and implemented with precision, can be a catalyst for substantial gains in explosive strength among adolescent basketball players[5, 6]. This research paper delves into the multifaceted realm of adolescent athletic development, specifically focusing on the effect of resistance training on increasing explosive strength in basketball players within the age range of 14-17. Through a comprehensive exploration of existing literature, empirical studies, and a rigorous examination of training protocols, this study aims to shed light on the potential benefits, risks, and optimal practices associated with resistance training in this demographic. By elucidating the intricacies of resistance training and its influence on explosive strength in adolescent basketball players, this research endeavors to contribute valuable insights to the fields of sports science, coaching, and athletic development. Ultimately, the knowledge gained from this investigation holds the promise of guiding coaches, trainers, and athletes themselves in making informed decisions regarding training strategies that can unlock the full athletic potential of the next generation of basketball stars.

METHODS

Sample Size

This study included a cohort of five male basketball players, ranging in age from 14 to 17 years.

Study Duration

The resistance training program spanned a duration of 10 weeks, with participants engaging in workouts twice a week on non-consecutive days.

Tools and Tests

To assess explosive strength, the following evaluations were employed

1. Vertical Leap Test (Sargent Jump Test)
2. Medicine Ball Throw

Inclusion Criteria

Inclusion criteria for participants were as follows

1. Male basketball players aged 14-17 years.
2. Absence of previous training in plyometrics or other strength-enhancing programs.

Exclusion Criteria

Exclusion criteria encompassed the following

1. Individuals not actively participating in basketball.
2. Age exceeding 18 years.
3. No history of prior injury.

Procedure

To investigate the hypothesis, two distinct groups were established: an experimental group and a control group. The experimental group completed a 10-week resistance training regimen, involving twice-weekly sessions on non-consecutive days, in addition to their regular basketball practice. Both groups underwent assessments using the seated medicine ball throw test to measure upper limb strength and the Sargent jump test to assess lower limb strength before and after the training period.

Materials Used

The following materials were utilized in the assessments:

1. Medicine ball
2. Stopwatch
3. Vertec apparatus for the Sargent Jump Test

Resistance Training Program

The resistance training program, initiated prior to the competitive season, featured the following exercises:

1. Upper Limbs: Decline Press, Pull Over, Lat Pull Down
2. Lower Limbs: Leg Press, Leg Extension, Leg Curl

The program commenced with two sets of 10 repetitions at 30-50% of the 1 repetition maximum (1 RM) and progressed to 80% of 1 RM. Each exercise consisted of 2-3 sets of 10-12 repetitions, with 2-3 minutes of rest between sets and 3-5 minutes following each exercise. After completing the resistance training, participants resumed their regular basketball training program.

Control Group

The control group engaged in a warm-up session followed by their customary basketball training routine, which comprised five sessions lasting approximately 30 minutes each week, along with two official games, each spanning 45 minutes and divided into four quarters of 12 minutes each.

Testing Procedure

Maximal Strength Assessment: All male participants underwent an assessment to determine their maximal strength, which was based on their one-repetition maximum (1 RM) in the decline press and leg press exercises. The 1 RM values were determined following the protocol established by Ramsay et al. (15). These assessments were conducted under supervision and with verbal encouragement. Each measurement was taken using a medicine ball, and for both upper limb and lower limb strength assessments using the Sargent jump test, three trials were conducted. In the Sargent jump test, participants were instructed to touch the Vertec, and corresponding marks were made. The best result from the three attempts was selected for subsequent analysis.

Seated Medicine Ball Power Throw Test

This test was used to assess upper body (arm) strength and explosive power while ensuring that the participant's back remained in contact with a wall. The equipment employed included a 4 kg (~8 lb) medicine ball, a wall, and a tape measure. The athlete assumed a seated position on the ground with legs fully extended and feet approximately 24 inches (~60 cm) apart, maintaining firm back contact with the wall. The athlete held the medicine ball with hands on the sides, slightly toward the center, with the rear of the ball against the center of the chest. Forearms were positioned parallel to the floor. The athlete executed a forceful throw of the medicine ball as far forward as possible while keeping their back in contact with the wall. The distance covered by the ball was recorded.

Scoring

The distance between the wall and the point where the ball landed was measured and recorded to the nearest centimeter. The best result from three throws was chosen for analysis.

Vertical Jump Test (Sargent Jump)

This test aimed to evaluate lower limb explosive power by measuring the height achieved in a vertical jump.

Equipment required
Measuring tape or a marked wall
Chalk for marking the wall (alternatively, 'Vertec' equipment could be used, as shown in the adjacent image).

Procedure
The participant stood beside a wall, facing it, and executed a jump using the hand closest to the wall.
While keeping both feet flat on the floor, the tip of the participant's finger was marked or recorded on the wall, representing the standing reach height. Chalk was applied to the participant's fingertips to mark the wall at the highest point of their vertical jump. The participant then positioned themselves away from the wall and executed a vertical jump, using both arms and legs to propel their body upward. The goal was to reach and touch the wall at the highest point of the jump. The score was determined by calculating the difference in distance between the standing reach height and the jump height.

Scoring
The best result from three jump attempts was selected for analysis.

STATISTICAL ANALYSIS
To evaluate the training's effectiveness within each group, a series of statistical analyses were carried out. Descriptive statistics, encompassing measures such as means and standard deviations, were employed to provide a summary of the dataset. To investigate changes over time and specifically to detect any significant interaction between groups and time, a repeated measures analysis of variance (ANOVA) was utilized. In this analysis, the significance level was set at $p < 0.05$, indicating that statistical significance was deemed achieved if the p-value was less than 0.05. This statistical approach facilitated the assessment of how both groups responded to the training intervention and whether any observed alterations were statistically significant.

RESULTS

Medicine Ball Throw Test Analysis
The outcomes of the Medicine Ball Throw Test provide a comprehensive overview of the data distribution, the correlation between pre-test and post-test scores, and the statistical significance of any observed changes. The mean values of the pre-test and post-test measurements serve as indicators of the central tendency within the dataset, while the variance offers insights into the dispersion or spread of the data points. Moreover, the Pearson correlation coefficient quantifies the degree of association between pre-test and post-test scores. (Table 2) For evaluating whether there exists a statistically significant difference between the pre-test and post-test scores, the t-statistic and its associated p-value are of paramount importance. In this specific instance, the calculated t-statistic (-0.88854) fall below the critical t-value (1.710882) for a one-tailed test, yielding a p-value of 0.191536. Given that the p-value exceeds the chosen significance level ($p < 0.05$), there is insufficient evidence to warrant the rejection of the null hypothesis, which posits that the mean difference is equal to zero. These findings strongly suggest that, in the context of the variable under investigation, no statistically significant difference existed between the pre-test and post-test measurements.

SARGENT JUMP TEST
The t-statistic, in conjunction with its associated p-value, plays a pivotal role in determining whether a statistically significant difference exists between the pre-test and post-test scores. In this particular case, the calculated t-statistic (-0.81088) fall below the critical t-value (1.710882) for a one-tailed test. The resultant p-value (0.2127) surpasses the chosen significance level ($p < 0.05$). Consequently, there is inadequate evidence to justify the rejection of the null hypothesis, which posits that the mean difference between the pre-test and post-test scores is equal to zero. (Table 2)
In light of these findings, it can be concluded that, within the scope of this study, there is no statistically significant distinction between the pre-test and post-test measurements for the variable under scrutiny. (Table 3)

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Analysis of the Medicine Ball Throw Test

The mean values for the pre-test and post-test measurements offer insights into the central tendencies of the dataset, demonstrating an increase from 4.7176 to 5.7792. These means represent the average values and suggest a noticeable improvement. Variance, in contrast, provides information about the spread or dispersion of the data points. In this case, both pre-test and post-test scores exhibit relatively low variances. The Pearson correlation coefficient, registering at 0.904638, indicates a robust positive correlation between the pre-test and post-test scores, signifying a strong association between the two. The t-statistic, in conjunction with its corresponding p-value, is used to evaluate the statistical significance of the observed difference between the pre-test and post-test scores. Remarkably, the calculated t-statistic (-9.90397) is substantially lower than the critical t-value (1.710882) for a one-tailed test. Additionally, the resulting p-value (2.97E-10) is markedly smaller than the chosen significance level ($p < 0.05$), indicating an exceptionally significant finding. Based on these compelling results, it can be confidently concluded that there exists a statistically significant difference between the pre-test and post-test measurements for the variable under examination in this study. The substantial increase from the pre-test to the post-test is statistically significant, suggesting that the intervention or treatment had a substantial and noteworthy effect on the variable being measured.

Analysis of the Sargent Jump Test

The mean values for the pre-test and post-test measurements provide insights into the central tendencies of the data, showcasing an increase from 20.68 to 23.56. Variance values reflect the spread or dispersion of the data points, with relatively similar variances for both pre-test and post-test scores. The Pearson correlation coefficient (0.850631) signifies a strong positive correlation between the pre-test and post-test scores, indicating a robust association. The t-statistic, along with its associated p-value, is crucial for assessing the statistical significance of the observed difference between the pre-test and post-test scores. In this case, the calculated t-statistic (-5.90673) is significantly lower than the critical t-value (1.710882) for a one-tailed test. Furthermore, the resulting p-value (2.14E-06) is much smaller than the chosen significance level ($p < 0.05$), indicating an extremely significant result. Based on these results, it can be concluded that there is a highly statistically significant difference between the pre-test and post-test measurements for the variable examined in this study. The increase from the pre-test to the post-test is statistically significant, suggesting that the intervention or treatment had a substantial and meaningful impact on the variable being measured.

Interpretation for Medicine Ball Throw Test

The results clearly indicate that there is no statistically significant difference between the pre-test and post-test measurements in the control group. However, in the experimental group, there is a highly statistically significant difference, suggesting that the Medicine Ball Throw exercise had a substantial and meaningful effect on the variable being measured.

Interpretation for Sargent Jump Test

The analysis reveals a highly statistically significant difference between the pre-test and post-test measurements in both the control group and the experimental group. This suggests that the Sargent Jump exercise had a substantial and meaningful impact on the variable being measured in both groups.

Comparison between Control and Experimental Groups for Medicine Ball Throw Test

In comparing the two groups, the mean value for the control group is 3.0712, while the mean value for the experimental group is 5.7792, indicating a substantial difference in means between the two groups. The variances for both groups reflect the spread or dispersion of the data points, with a higher variance in the experimental group. The t-statistic (t Stat) is employed to assess whether the difference in means between the control and experimental groups is statistically significant. In this case, the calculated t-statistic (-9.41237) is significantly lower than the critical t-value (1.684875) for a one-tailed test. The resulting p-value (6.91E-12) is much smaller than the chosen significance level ($p < 0.05$), indicating an extremely significant result. Based on these results, it can be conclusively stated that there is a

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highly statistically significant difference in means between the control group and the experimental group for the Medicine Ball Throw exercise.

Comparison between Control and Experimental Groups for Sargent Jump Test

In comparing the two groups, the mean value for the control group is 20.16, while the mean value for the experimental group is 23.56, indicating a difference in means between the two groups. The variances for both groups reflect the spread or dispersion of the data points, with a higher variance in the experimental group. The t-statistic (t Stat) is employed to assess whether the difference in means between the control and experimental groups is statistically significant. In this case, the calculated t-statistic (-2.91633) is significantly lower than the critical t-value (1.677927) for a one-tailed test. The resulting p-value (0.002707) is less than the chosen significance level ($p < 0.05$), indicating a statistically significant result. Based on these results, it can be concluded that there is a statistically significant difference in means between the control group and the experimental group for the Sargent Jump exercise.

DISCUSSION

The primary objective of this study was to investigate the impact of resistance training on explosive strength in adolescent basketball players. Upon analyzing the data, it was revealed that there is a significant difference between those who underwent the resistance training program and the control group. Furthermore, it was observed that the players in the study were subject to certain influences. Research has indicated that the use of medicine balls in training may have the potential to limit the development of explosive force in the upper extremities (Gambetta, 1986)[7]. In basketball, passing techniques vary, including chest passes, overhead passes, and side passes. These aspects play a crucial role in a player's defensive abilities and decision-making on the field. Another noteworthy aspect is the impact of maturation and growth on the enhancement of explosive power in male athletes. During this developmental phase, there is a positive correlation between chronological age, physical development, and explosive strength. Various body weights and physical attributes may influence these factors[8]. Consequently, after conducting group analyses, disparities in the assessment of explosive force were observed, underscoring the importance of considering male growth, development, and maturation factors in this context. Explosive power is vital for basketball players as it is utilized for actions such as jumping, quick acceleration, rapid changes in direction, deceleration, and precise ball passing. Numerous studies have delved into this area, emphasizing the significance of explosive power in basketball performance [9-12]. According to research, players with higher competence levels tend to exhibit greater jumping abilities compared to their less skilled counterparts [13-15]. Furthermore, it is suggested that incorporating plyometric training following resistance training may yield even better results. Plyometrics, a widely used method in practice, is unsurprisingly popular as it involves exercises that transition the natural muscle contractions from eccentric to concentric, often involving jumps. Such exercises align with the demands of various sports, including basketball [16]. Plyometric training is characterized by a stretch-shortening cycle (SSC), which involves reversible contractions. This type of training has the potential to significantly improve change of direction speed in basketball players. In summary, this study sheds light on the importance of resistance training and its potential combination with plyometric training to enhance explosive strength in adolescent basketball players. It underscores the influence of growth and maturation factors in this context, emphasizing the multifaceted nature of developing explosive power in athletes.

CONCLUSION

This study highlights the positive impact of a 10-week in-season resistance training program targeting both upper and lower body strength on the vertical jump and Medicine ball throw performance of adolescent male basketball players. These improvements hold significant clinical relevance as they contribute to enhanced basketball performance. Importantly, it's worth noting that this program did not place additional strain on the skeletal muscle development of adolescents.

CONFLICT OF INTEREST

No conflict of interest declared by the authors.

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Table 1. Resistance Training Program

NO	EXERCISES	REPETITIONS
1	Decline press	10 rep × 1,2&3 sets
2	Leg press	10 rep × 1,2&3 sets
3	Lat pull down	10 rep × 1,2&3 sets
4	Leg extension	10 rep × 1,2&3 sets
5	Pull over	10 rep × 1,2&3 sets
6	Leg curl	10 rep × 1,2&3 sets

Table 2. Pre-test and post-test values of medicine ball throw test

	PRE TEST (m)	POST TEST (m)
Mean	2.978	3.0712
Variance	0.304825	0.543394
Observations	25	25
Pearson Correlation	0.704151	
Hypothesized Mean Difference	0	
Df	24	
t Stat	-0.88854	
P(T<=t) one-tail	0.191536	
t Critical one-tail	1.710882	

Table 3. Pre-test and post-test values of Sargent Jump test

	PRE-TEST	POST TEST
Mean	19.92	20.16
Variance	20.32667	14.55667
Observations	25	25
Pearson Correlation	0.95031	
Hypothesized Mean Difference	0	
Df	24	
t Stat	-0.81088	
P(T<=t) one-tail	0.2127	
t Critical one-tail	1.710882	

RESEARCH ARTICLE

Strengthening of RC Beams in Flexure using Textile Reinforced Mortar (TRM)

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ABSTRACT

This study evaluated the performance of several textile layers and fibre types, including basalt and AR-glass fibres, when employed as mortar reinforcement (TRM) in an effort to improve the flexural behaviour of reinforced concrete beams. Six RC beams in total were cast and tested using just two points of bending. Two beams without TRM layers were employed as control beams. The remaining four beams were strengthened using externally bonded textile reinforced cement that had two kinds of textile fibres and unique textile layers. The load is gradually introduced using a hydraulic jack with a 500kN capacity, and it is then evenly distributed on the beam specimen using an I-section steel spreader. It was revealed that the reinforced beams with Basalt textile layers greatly outperformed the control beams in terms of first fracture stress, ultimate strength, flexibility, and reduced crack width. The overall improvement in flexural capacity brought about by TRM strengthening ranged from 22.72% to 31.81% for all strengthened beams. When compared to the control beam, all strengthened beams behaved stiffer, with the benefit being most apparent when the steel reinforcement failed due to the full activation of the textile fibres under tension. The overall increase in Stage II flexural stiffness (cracked portion, prior to yielding) was 8.33-18.43%.The basalt TRM specimen with six layers of textile fibres displayed higher bending strength than the more AR-glass textile fibers.

Keywords: AR-glass, Basalt, Textile Reinforced Mortar, Flexural behaviour.

INTRODUCTION

Existing reinforced concrete (RC) structures require structural retrofitting due to ageing, environmental deterioration, lack of maintenance, the need to follow current design specifications for the duration of their service life, or any combination of these problems. Engineers have embraced fiber-reinforced polymers (FRPs), an externally bonded composite material, more and more as a retrofitting technique over the past two decades. FRPs do, however, have some drawbacks, many of which are connected to the use of epoxy resin. They are expensive, cannot be used in cold climates or on damp surfaces, have low water vapour permeability, and operate poorly at high temperatures, among other drawbacks. Later, TRM steadily attracts the attention of the structural engineering community. TRM is an inexpensive fire-resistant material that clings well to masonry and concrete substrates and may be applied to cold or wet surfaces. For the reasons mentioned above, TRM makes more sense than the more widely used fiber-reinforced polymers (FRPs) for strengthening pre-existing concrete and masonry structures. How to evaluate the FRCM's uniaxial tensile characterization [1] Modern cement-based materials called Fabric Reinforced Cementitious Matrix (FRCM) composites, which are constructed of dry-fiber fabric embedded in an inorganic matrix, are designed to be retrofitted into masonry or concrete structures. The tensile behaviour characteristics of this composite under varied boundary conditions were examined using two test rigs. A clevis grip (pin action) was used to model the field boundary conditions of a typical installation in order to get design parameters.

By causing tensile failure in each of the component materials, a clamping grip was employed to entirely define the composite. The experiment made use of a number of FRCM systems, including those made of glass, carbon, poly paraphenylene benzobisoxazole (PBO), and carbon. In textile-reinforced concrete (TRC), a type of reinforced concrete, fibres or textiles are utilized in place of traditional reinforcement. Strong textile threads are used to create flexible and long-lasting concrete structures. In the literature, TRC is only applied for nonstructural and retrofitting purposes. Test textile reinforced mortar system testing procedures is the second goal of this article. Describe how the research on the usage of TRC as a structural member has changed. The tensile and bond behaviour of TRM was described in [3]. Textile-Reinforced Concrete (TRC), a cementitious composite material, is reinforced with a carbon or glass fabric. TRC makes it possible to build structures that are light and thin with reduced concrete covers and enhanced lifespan because there are no corrosion problems. The behaviour of TRC components that have been under tension is examined in this article via an experimental and theoretical investigation. The failure load of the composite might be less than the failure load of bare textile [4]. The effects of the reinforcing ratio, steel fibre volume %, and prestressing on the uni axial tensile behaviour of carbon textile reinforced mortar (CTRM) are investigated in this paper using uniaxial tensile testing. Using the tried-and-true anchorage techniques, the composite specimens' peak strength and breaking strength could be increased to 66.1 and 97.9%, respectively [6].

A description of modern technologies [7]. Flexural Behaviours of a Sandwich Panel Made of EPS, Foam, Concrete, and Glass Fibre [8]. The flexural behaviour of TRM-enhanced beams was assessed in this study while taking the likelihood of intermediate crack debonding into account [9]. Flexibility of TRC after carbon and glass fibres is added [10]. RILEM TC 232-TDT recommends test procedures for the design of textile reinforced concrete [11]. Basalt textiles rein forced's tensile characteristics(BTRM) [12]. The creation of textile-reinforced self-stressing concrete, which boosts concrete's resistance to cracking, combines self-stressing concrete and textile. The confinement effect of textile can cause self-stresses to form in the concrete matrix, considerably boosting crack resistance [13]. Numerical models are developed for RC beams with TRC composite fixes [14]. The mechanical bending behaviour of mineral matrix composite beams with textile reinforcement is studied. The two types of E-glass fiber-based textile reinforcement that are taken into consideration (CSM) are unidirectional rovings and chopped strand mat. The mineral matrix made of inorganic phosphate cement (IPC) has the advantage of not being alkaline [15]. Constructions that require reinforcement and are susceptible to quasi-static loads are particularly well suited for TRC. The best technique for sustaining structures during impact is SHCC. By repairing or strengthening layers constructed of TRC or SHCC, RC constructions can be made to last for a very long time. Numerous microscopic fissures exist throughout TRC and

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SHCC, and it is essential that they have the ability to seal off and permit the passage of liquids and gases. Practical applications show that the TRC and SHCC have a huge potential for rehabilitating concrete structures [16]. Basalt cloth reinforced mortar-based composites are subjected to uniaxial tension using a nonlinear analytical model [17], [18]. Sandwich TRC panels are constructed using multis cale mechanical textile reinforced concrete models [19].Rigidity TRC efficiency ratios are higher than strain strength TRC efficiency ratios. An inventive in-plane shear test was developed to evaluate TRCs. TRC with aramid fibres had much better in-plane shear behaviour when compared to glass [20]. Tensile properties of the BTRM [21] and the impact of the TRC's short-dispersed carbon and glass fibres [22].Concrete and TRM are combined [23].

MATERIALS USED IN CONCRETE

OPC 53grade, which complied with IS 12269-2013, was used in the experimental examination. The fine aggregate is made out of naturally occurring river sand that may be easily found nearby and that can pass through a 4.75mm screen. With a specific gravity of 2.61 and a fineness modulus of 2.88, it complies with zone II. Crushed, angular coarse material was separated based on size. It was sieved and divided into five groups in line with IS 383-1970: passing through 10mm retained on 4.75mm, similarly 12.5-10mm, 16-12.5mm, 20-16mm, and 20-4.75mm. Water is an essential component of concrete because it actively participates in the chemical reactions involving cement to produce the hydration product, calcium-silicate-hydrate (C-S-H) gel. Potable water that was on hand in the lab and complied with IS: 456-2000 standards had a pH value between 6 and 8 and was used for mixing the concrete and curing the specimens. The super plasticizer also produces homogenous, cohesive concrete that is frequently devoid of bleeding and segregation problems. The chemical admixture "CONPLAST SP 430," which is based on sulphonated naphthalene formaldehyde, was used in this study. The concrete was made using traditional techniques, and its 28-day compressive strength was 30 MPa

Mechanical properties of conventional concrete
The most common test is the compressive strength test, which was carried out on cube specimens with dimensions of 150 mm x 150 mm x 150 mm utilizing a 3000 kN AIMIL digital compression testing apparatus. At room temperature, three samples of each mix combination were examined. The splitting tensile strength tests were carried out on concrete cube specimens with dimensions of 150 mm x 150 mm x 150 mm at a 28-day age using a compression testing machine with a 3000 kN capacity. In order to determine the flexural strength in line with the specifications of IS: 516-2004, flexural strength tests were carried out on the prisms at a 28-day old utilising a 1000 kN capacity flexural testing machine. The E for concrete values is computed in accordance with (IS 456, 2000) using cylindrical specimens with a dimension of 150 mm x 300 mm. In order to conduct this test, a total of three cylinders of the standard mixture were cast and given a 28-day curing period.

Reinforcement
Rebars with diameters of 12 mm at the bottom (tension zone), 10 mm at the top (compression zone), and stirrups with diameters of 8 mm spaced 150 mm c/c in the beam were used as reinforcement; Table 2 lists the mechanical characteristics of these reinforcements. Testing for reinforcement is shown in Figure 2.

Mortar
A ready-mix polymer mortar [9] with a w/p ratio of 0.24 was used as the mortar to achieve the plastic consistency required by TRM. The mortar's compressive and tensile strengths were calculated using cube and cylinder measurements of 70.6x70.6x70.6mm and 100x200mm, respectively. The mortar had an average compressive strength of 45 N/mm2 and an average tensile strength of 4.5 N/mm2 after 28 days. A textile with roving fibres woven in the warp and weft orientations with a mesh size of 5x5mm composed of glass and basalt. The textile fibre mesh inside the plate specimen acts as interior reinforcement. A product data sheet that describes the mechanical properties of the textile fibre used in the production process is shown in Figure 3.

PREPARATION OF SPECIMEN AND TEST METHOD
Preparation of specimen

Six beams that measured a combined 3000 mm in length, 250 mm in depth, and 150 mm in width were cast and tested. Four points of loading on each beam were put to the test over a real span of 2800 mm. The remaining four beams, beams 3 to 6, were strengthened with TRM using two different textile reinforcing materials, AR-Glass and Basalt fibre, with various amounts of textile layers (4 and 6). Two of the six beams, beams 1 and 2, were employed as ideal beams (reference beams). The overall thickness of the TRM strengthening was 10mm. The number of layers was determined based on the strength demonstrated in the uniaxial tensile and flexure behaviour of TRM plate. Before casting the beam, moulds are assembled and their insides are oil-coated. The next step is to insert the reinforcement structure into the mould, and then add cover blocks measuring 25 mm to the bottom and side sides of the reinforcement. To prevent bulging when the concrete is being poured, the top of the mould is next fastened with an angled piece of steel. Following the operations, new concrete is poured into the beam mould. The side shutters are removed after 24 hours, and the beams are then left to cure for 28 days while being protected by a gunny sack.

Textile Reinforcement Ratio, P_f (%) = A_f/bh

Where, b and h = width and depth of the beam, A_f = cross-sectional area of textile fibres (= txb).

Strengthening procedure

The TRM strengthening element was externally attached to the bottom of the RC beams across a length of 2700mm. A grinding machine was used to roughen the surface and create a grid of grooves with a depth of around 3 mm in order to strengthen the binding between the old and new reinforcing material. Prior to laying down the mortar layer, water should be applied to the concrete surface. TRM plate has four textile layers that support the top, bottom, and centre mortar layers, which are each 2 mm thick. The mortar thickness in TRM with six textile layers is 1 mm between layers and 2.5 mm on top and bottom. The first stage in creating TRM was applying a mortar layer with the proper thickness. To ensure mortar impregnation, the textile layers were then placed on top of the mortar layer and carefully pressed into place by hand. Apply a second mortar coat after that. Additional layers of material were added and the same process was repeated. Before being inserted into the mould for 24 hours, the last layer of fabric was evened up and given the proper amount of cement. After a total of 28 days of curing, all of the beams were removed for testing.

Test Set-Up

Before placing the beam specimen into the loading frame, the length of the beams is measured and divided into three portions (L/3). Then, grid patterns are formed in the beam's flexural zone to measure the fracture diameters. Based on the length of the beam specimen, the loading frames' hinged and roller supports are positioned suitably. After that, the beam is set up in the loading frame. A two-point loading scenario was employed to gauge the simply supported beams' strength. The laboratory's setup for loading the beam is shown in Figure 8. A 500kN capacity hydraulic jack is used to progressively introduce the load, and an I-section steel spreader is then used to distribute it to the beam specimen. Demec gauge pellets are placed to the concrete surface to measure the surface strain manually. A 0.01 least count dial gauge was used to measure the deflection at mid span. Figure 8 illustrates the use of a mechanical dial gauge to determine the ultimate deflection after the beam has reached its maximum load. After the load has been imposed by the hydraulic jack at 2.5kN intervals, it is deliberated using a proving ring

TEST RESULTS AND DISCUSSION

Observations such deflections, concrete surface strain, and beam face cracks are noted at each load increment. The initial fracture load, final crack load, failure type, and load bearing capability are all closely observed and recorded. The load, deflection, moment, fracture breadth, and failure type are all listed in the final experimental observations for each group in the Table.3. Figure 9 compares the responses of the reinforced specimens and the control specimen (CON) as it depicts the behaviour of the specimens in terms of load against mid span deflection curves. All specimens exhibit a three-staged flexural response up to the peak load, as shown in Fig. 9, which corresponds to three almost linear branches of the load-deflection curves. Uncracked beam in Stage I. Stage II: cracks growth and steel reinforcement yielding. Stage III: the post-yielding reaction and failure.

1. A first branch from the unloaded state to the point of initial flexural cracking of concrete; this branch corresponds to Stage I: uncracked section (elastic);
2. A second branch from the point of initial flexural cracking of concrete to the point of yielding of the tensile steel reinforcement; this branch corresponds to Stage II: cracked section (still elastic but with reduced stiffness);

And a third branch that originates at the point of tensile steel reinforcement. Or, in the case of the retrofitted beams, complete activation of the TRM composite.

Figure 9 illustrates how the addition of TRM-strengthening enhanced the strengthened beams flexural response when compared to the performance of CON beam. Stage I were very little impact from the strengthening layers. However, Stages II and III were when the TRM reinforcement was most apparent. Particularly, during Stage II, the progressive development of the flexural cracks activated the TRM composite under stress, resulting in an increase in its flexural stiffness and yield load. All strengthened beams failed as a result of the strengthening operation dropping out, which showed up in various forms as shown in Figure 11. Fibre rupture, or FR, is the term used to describe the rupture of textile fibres in the region of maximum bending moments (Fig. 11). This failure pattern was present in specimens made of basalt textile and glass textile fibre. The TRM's bottom face showed multiple cracks, but only one noticeable crack that was substantially bigger occurred where thefibres were ruptured (Fig. 11)..

The cracks that begin in the strengthening layers and spread to the beams (Figure 12) demonstrate the increased compatibility of the matrix within the textile fibre and with the beam, which increases the beams stiffness, enhances flexural strength, and slows the development of cracks compared to control beams. Additionally, TRM raises initial fracture load from 15kN to 22.5kN compared to the control beams 15kN.

Bending stiffness

The pre cracking, cracking, and post-yielding bending stiffness of the tested beams are all listed in Table 4. It was calculated using the load at mid-span deflection curves. As shown in Table 4.20, the use of TRM strengthening increased the cracking and post-yielding stiffness in comparison to the reference beam. It should be noted that the researched parameters, including the strengthening system (TRM), the quantity of TRM layers, the type of fibre used in the textile, and the strengthening configuration, had an effect on the rise in the cracking and post-yielding stiffness.

CONCLUSION

The effect of TRM composites on RC elements when applied externally to increase their flexural capacity was investigated experimentally by altering the type of textile fibre and the number of layers. Six RC beams in all were built, and their resistance to simple 4-point bending was tested. Two beams served as the control specimen and were studied in their unenhanced, as-built state while four beams underwent TRM strengthening. Four vs. six reinforcing layers, a basalt and glass fibre textile with a small mesh size of 5mm, and these were the variables considered

The important conclusions of this inquiry are listed in the list below

The volume percent of the fibres, the number of textile layers, and the type of fibre are the three main determinants of TRM strength. The vertical strands in the weft filament yarn of the textile fibre known as the warp support the majority of the tensile load during testing. The majority of the flexure stress is carried by the weft of the horizontal strands. Strength is influenced by the volume % of the warp and weft as well as the number of textile layers. When compared to control beams, the experimental results of undamaged reinforced beams revealed a considerable delay in the development of the initial cracking and a large reduction in crack breadth. The overall enhancement in flexural capacity brought about by TRM strengthening ranged from 22.72% to 31.81% for all strengthened beams. Overall, the type of mortar significantly influenced how well TRM enhanced flexural performance of RC beams. All strengthened beams behaved stiffer when compared to the control beam, with the benefit being most noticeable when the steel

reinforcement went out as a result of the full activation of the textile fibres under tension. Stage II flexural stiffness (cracked section, before yielding) increased overall by 8.33-18.43%, whereas Stage III stiffness (cracked section, after yielding) increased by 551.16-1520.15%. Both AR glass and basalt textile performed better in terms of flexure strength due to the enhanced compatibility between the old and new TRM strengthening procedures. Basalt has a greater moment-carrying capacity than AR glass. When the maximum stress is reached, basalt textile breaks down ductile whereas glass breaks down brittlely. This serves as an illustration of how TRM can be applied as a motivating technique for creating and enhancing structures. A few tests employing two different types of textile fibre materials led to the conclusion. To strengthen the trust in the results, additional research is needed, including on substitute textile fibre kinds that would have the same volume proportion of fibres.

ACKNOWLEDGMENTS

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Table 1. Mechanical properties of control specimen

Code mix	Compressive strength in MPa	Split tensile strength in MPa	Flexural strength in MPa	E for Concrete MPa
CC	40.79	4.08 N/mm^2	5.33	32041

Table 2. Mechanical properties of Reinforcement bar.

Size of bar	Yield stress N/mm^2	Ultimate stress N/mm^2	Nominal breaking stress N/mm^2	Actual breaking stress N/mm^2
12mm	435.47	585.28	489.86	749.45
10mm	439.67	539.62	459.63	774.23
8mm	426.89	563.49	489.41	747.73

Table 3 Mechanical properties of mortar

Compressive strength @ 28 days	45 N/mm²
Tensile strength @ 28 days	4.5 N/mm²
Flexure strength @ 28 days	8 N/mm²
Bond strength @ 28 days	11 N/mm²

Table 4. Summary of beam details

S.No	Beam code	Type of textile reinforcement	No.of layers	Thickness of textile fibre	Reinforcement ratio	
					P_t (%)	P_f (%)
1	CB1 CB2	-	-	-	0.68	-
2	BG4	AR–Glass Textile	4	0.035	0.68	0.056
	BG6	AR–Glass Textile	6	0.035	0.68	0.084
	BB4	Basalt Textile	4	0.047	0.68	0.075
	BB6	Basalt Textile	6	0.047	0.68	0.113

Table 5. Experimental results of RC Beams

Beam Code	Load (kN)			Deflection (mm)			Capacity Increase (%)	Failure mode
	Crack (P_{cr})	Yield (P_y)	Ultimate (P_u)	Crack (δ_{cr})	Yield (δ_y)	Ultimate (δ_u)		
CB(1,2)	15	52.5	55	2.37	13.24	30	-	CC
BG4	20	55.0	67.5	2.46	12.80	21.33	22.72	FR
BG6	20	62.5	70.0	2.2	13.82	20.2	27.27	FR
BB4	20	57.5	69.10	2.4	12.26	19.2	25.63	FR
BB6	22.5	62.5	72.5	2.28	13.62	18.4	31.81	FR

Table 6. Comparison of stiffness at various stages

Beam Code	Pre-cracking stiffness (kN/mm)	Cracking stiffness (kN/mm)	Post-yielding stiffness (kN/mm)
CB (1,2)	6.32	3.96	0.129
BG4	8.13	4.29	1.46
BG6	9.09	4.52	1.17
BB4	8.33	4.69	1.67
BB6	9.86	4.58	2.09

Figure 1. Concrete specimens test setup	**Figure 2 Testing of reinforcement bar**
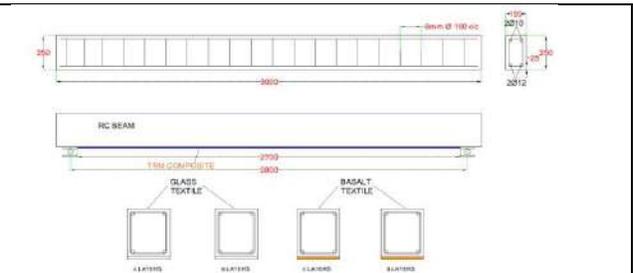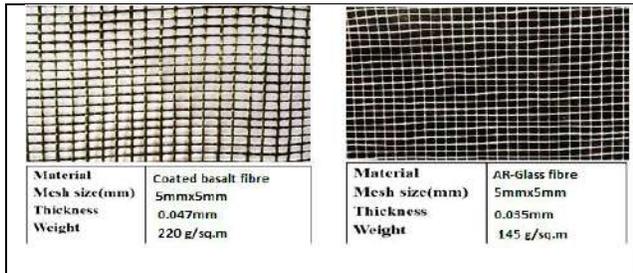
Figure 3 Textile used in this study; (a) coated basalt fibre, (b) AR-Glass fibre.

Figure 4. Reinforcement details of RC beams

Figure 5 Surface preparations of beams

Figure 6 Strengthening procedure of AR Glass textile reinforcement

Figure 7 Strengthening procedure of Basalt textile reinforcement

Figure 8 Beam test set-up
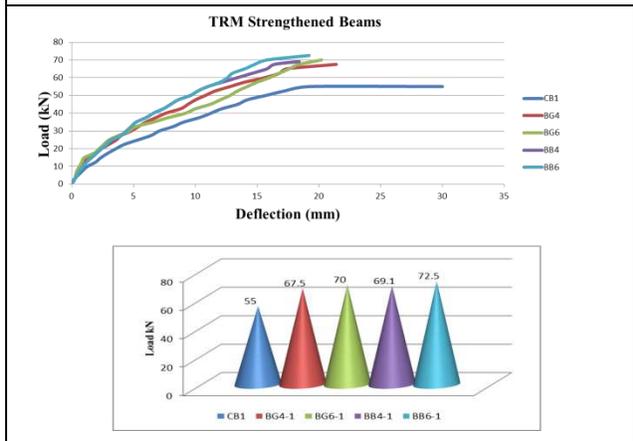
Figure 9 Load-deflection graph and comparisons of test results

Figure 10 Failure of TRM strengthened Beams

| Figure 11 Rupture of the textile reinforcement fibre | Figure 12 Compatibility of TRM to existing RC beam |

RESEARCH ARTICLE

Analysis of Human-Computer Interaction for Traditional Healthcare: A Broad Survey

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ABSTRACT

One of the leading technologies in the computing field is Human-Computer Interaction (HCI). Many industries are trying to use the advantages of this digital technology by integrating it into different functions. This paper presents a survey of Traditional Healthcare based on HCI aspect. This survey proposes the essential background by outlining the HCI paradigms and Human-Computer Interaction fundamentals at the outset. Then the Traditional Healthcare life cycle is extensively analyzed. We also review various concepts and results from different authors, which incorporate extensive research and suggestions made in traditional healthcare. Eventually, based on the assessment, we spotlight possible future research directions, especially in Siddha medicine pulse diagnostics and Manikkadainool. The study covers a broad spectrum of middleware solutions, devices, applications, features, approaches, models and sensors developed in the base of HCI for Traditional Healthcare industry, called the Human-Computer Interaction in Traditional Healthcare (HCITH). Our objective involves not just evaluating, contrasting, and amalgamating prior research efforts, but also appraising research discoveries and scrutinizing their importance for Human-Computer Interaction (HCI).

Keywords: Human-Computer Interaction, Traditional Healthcare, Siddha medicine, traditional diagnosis, pulse diagnostics.

INTRODUCTION

There has been a sustained and enduring fascinationin Human-Computer Interaction (HCI), a notion used in 1980 to describe the scheme of computer technology. The textbook "The Psychology of Human-Computer Interaction" uses a phrase Human-Computer Interaction, which became generalized at 1983 [1]. Computing technology has the domain of "Human-Computer Interaction" (HCI) has applications that investigate how human (users) communicate with systems by creating, assessing, and implementing user interfaces for computers that are delicate to the requirements and behaviour of a particular user. It lies at the juncture of several fields, including psychology, computer vision, artificial intelligence, facial recognition, motion tracking, scientific technology, and so on. It is an interdisciplinary area that includes computer science, cognitive science, behavioural science, design, and other disciplines. A specific underlying purpose of HCI is to design better user-friendly as well as effective computing systems. The client collaborating with computers via a user interface that allows them to alter the plan and communicate information. HCI places a high priority on user interface design, implementation, and evaluation [2]. Since then, HCI research has become a well-known research topic in computer science. As we'll see in Section III, several academics have given definitions and explanations for various aspects of HCI. Researchers and engineers have used HCI advanced developed techniques to create many prototypes, systems, and solutions over the previous two decades [3]. There has been an increasing emphasis in recent years on enhancing all aspects of Human-Computer Interaction.

 To achieve genuinely successful Human-Computer Intelligent Interaction (HCII), the computer must engage quickly with the user, as human-human interaction occurs [4]. The extensive use of the internet and interfaces has had an influence on the era of personal computing. Even though accessing the Internet quadrupled yearly with great frequency, it took decades- for the Internet to reach a significant portion of the population. *The first outcome product is The Xerox Star provides a complete Graphical User Interface* (GUI) in 1981 [5]. Traditional medicine has been practiced for and embraces knowledge passed down via multiple means. "The World Health Organization (WHO) defines Traditional Medicines (TM) as a wide array of health practices, approaches, knowledge, and beliefs that encompass the use of plant, animal, and spiritual therapies, as well as manual techniques, either individually or in combination, with the aim of promoting well-being and addressing the treatment, diagnosis, and prevention of illnesses"[6]. Some TM systems have been noted, and they explain complex medical treatments ,based on ideas and significant experience. Such methods are commonly employed both inside and outside country limits. Some of the Asia's significant Traditional Medicine Systems (TMS) are Ayurveda, Kampo, Thai medicine and Chinese traditional medicine. Traditional healers use some oral and non-written traditions known as "folk medicine" on a small number of people in their community. [7].

Chemical industries, which formed as the first pharmaceutical firms, drove TMS out of the market in industrialised countries from the nineteenth century forward. By leveraging academic discoveries and technological breakthroughs, these chemical businesses ventured out to produce more standardized and effective pharmaceuticals. Given the phenomenal rise of the pharmaceutical sector manufacturing contemporary allopathic drugs in India during the 1980s, it would have been easy to assume that the TM sector would have also died a natural death there [7].Most developing countries have two types of healthcare systems: One is 'modern' and 'scientific' in character, and they originated in the West. The other is traditional, time-tested, and originated in the country. TMS is based on practices throughout the world. TMS has an extensive heritage in India and utilizes locally available natural ingredients. India has developed five major traditional medical systems: Ayurveda, Siddha, Unani, Yoga, and Homeopathy. According to the WHO, the amount and quality of data on the safety and performance of TM are lacking to fulfill the conditions for its worldwide use. The need for healthcare is increasing, driving the development in healthcare technologies [8], [9], [10]. This survey focuses on the fundamentals of the HCI paradigm, fundamentals of traditional medicine, characteristics, types and classification, levels and life-cycle, existing research prototypes, HCI approach for Traditional Healthcare, etc. This section discusses the HCI paradigm briefly. We are not only conducting a study of the HCI, but we are also providing some basic information that helps in understanding the historical significance and current direction of technology, such as HCI's evolution, statistics related to HCI,

highlighted technologies, characteristics, and research gaps in the HCI paradigm. The theories and attributes are defined in the HCI paradigm. It also shares key concepts with other branches of computer science. We utilize current technology based on the HCI's characteristics and requirements.

Human-Computer Interaction Paradigms
Evolution of Human-Computer Interaction
Before delving deeply into the realm of HCI, it proves advantageous to delve into its evolutionary journey. Preceding the advent of the Internet, the primary focus of researchers in the realm of Human-Computer Interaction (HCI) revolved around providing appropriate input and output interfaces for personal computers. The public's desire was for these interfaces to possess utmost simplicity and clarity. Consequently, HCI has evolved into a multidisciplinary domain spanning realm from electronics and computer science to sociology and psychology. The fruits of this research materialized as hardware and software components that have now become ubiquitous in our everyday lives – examples include keyboards, mice, graphic tablets, touch screens, speech and audio devices, among others. These innovations paved the way for the extensive integration of computers into daily use and their widespread adoption across the globe. [11].

Graphical User Interfaces
The most significant HCI standard is graphic user interfaces (GUI). It had a huge influence on the next generation of computer users, resulting in the development of countless new applications. A Graphical User Interface (GUI) provides users with the means to engage with an extensive array of devices, spanning from computers, mobile phones, and portable media players to game consoles, home appliances, office furnishings, and beyond. Unlike text-based interfaces, a GUI provides graphical client elements and visual pointers such as windows, symbols, and menus. Exercises in a GUI are frequently accomplished by manipulating graphical things, using a mouse, and less frequently by using a console. Its ability to make the computer operation plain, straightforward, and easy to comprehend and use is a big benefit.

Tangible User Interfaces
Users may prefer to operate with "analogue" real-world tools rather than existing digital technology. Tabletop displays and touch pens, as well as other big surfaces, have been selected. Bridging the divide separating the virtual realm from the tangible reality, Ishii and Ullmer [12] unveiled a novel incarnation of HCI titled "Tangible User Interfaces" (TUIs) in 1997. Rooted in Weiser's concept of ubiquitous computing, their vision involved enhancing the physical world by seamlessly embedding digital information into ordinary objects and scenarios. This approach facilitates the provision of real-world mechanisms to manipulate virtual data, conceptual abstractions, and various functionalities.

Voice-based User Interfaces
Voice User Interfaces (VUI) provide users to converse using natural language. Users can connect with computers using a voice-to-speech engine. The "conversational PC" has been a focal point for artificial consciousness research in speech innovation (simulated intelligence). The idea is to transform human intelligence into computer by enabling users to interact with computer-based applications using everyday spoken language. When a voice is employed as a means of contact, two symmetric computing concerns arise: automated text rendering and human speech recognition. [13,14]

Intelligence - Computer Interfaces
A technology that allows the human brain to communicate directly with one or more external systems is called Intelligence-Computer Interface [15]. The majority of research has been on utilising BCI to control rehabilitation, and interfaces in order to assist, improve, or restore human cognitive or sensory-motor skills. A combined set of software, sensors, and actuators can monitor and use human brain impulses and activities. Because the activities have the potential to support, enhance, or restore human cognitive or sensory-motor functions, natural human-to-

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human connections may become easier. Simultaneously, mind-based exercises can be used for virtual informal organisations and game collaborators.

What is Human-Computer Interaction

Along with sociology, cognitive science, psychology and human factors engineering and design, HCI loomed as discipline of computing technology in the early 1980s. HCI has evolved rapidly and consistently over the last three decades, recruiting people from a large range of areas and incorporating broad ideas and techniques. HCI currently comprises various semi-autonomous fields of study and practice in human-centered informatics. *Definition by [16]:* "According to the Association for Computing Machinery (ACM), human-computer interaction is a field of study that focuses on the design, evaluation, and implementation of interactive computing systems meant for human use. Additionally, it involves the examination of significant phenomena related to these systems."*Definition by [17]: "As defined by Alan Dix, Human-Computer Interaction (HCI) is the exploration of the impact of computer technology on human work and activities." Definition by [18]: "Human-Computer Interaction (HCI) is a specialized area within computer science that focuses on examining how people (users) interact with computers. It involves the design, evaluation, and implementation of user interfaces for computer systems, aiming to accommodate the user's needs and behaviors."* End-User Level contentment in Computing, often known as user contentment, is an essential aspect of HCI. The way humans interact with a computer system is the user interface. A computer system's user interface allows users to engage with the plan to use it and achieve their goals [19]. The interface is important in the numerous ways in which humans and computers connect with one another. HCI (human-computer interface) is also known as HMI, MMI, and Computer-Human interface (CHI). Desktop programmes, web browsers, mobile PCs, and computer kiosks all employ graphical user interfaces (GUIs) today [20]. Good HCI design hides all operational complexity and simplifies and simplifies the user experience. The user will feel at ease and find exactly what they are seeking for because of their clear and logical reasoning. VUIs (voice user interfaces) and emerging multi-modular frameworks are synthesizing and speech recognition [21]. The interaction loop is of streaming information which is made up of several components, including:

1. Oriented on Vision: Human-Computer Interaction provides a broader variety of expressive input capabilities by analyzing data from one or more cameras using Vision-based HCI approaches. For the reliable anticipation of crucial visual user information, computer vision can serve as an unobtrusive, non-contact input channel within the framework of HCI. [22].
2. Audio-based interaction: The critical interaction between the machine (AI based auditory device) and the user is termed as Audio-based interface systems. This file contains data received from a number of audio streams. The user-imposed circumstances and objectives comprise the user's task environment. The machine environment is the computer's operating environment. Human and computer processes, rather than interacting, focus on non-overlapping interface zones [28].
3. Intelligent personal assistants such as Siri from Apple, Google Now from Google, and Amazon Echo from Amazon are examples of a new generation of audio-based human-computer interaction. One shortcoming of intelligent personal assistants (IPAs) is that their speech is "emotionless" [25].

HCI Application Domains

The subject of human-computer interaction (HCI) is quickly evolving due to the advent of unique multi-sensory user interfaces. Intelligent gadgets, data processing engines, and huge interactive screens are becoming increasingly popular [23]. In addition to the keyboard and mouse, multimodal interfaces (two or more inputs) are being employed. Among these are handheld controllers, multi touch models, gesture recognition, voice and translation, emotional detection, various display technologies, collaboration technology, mixed reality, and context-sensitive interfaces [23,24]. The most recent breakthroughs include wireless, wearable, and virtual reality technology. HCI aspires to blend cutting-edge technology like as animation and networking, with time-tested interaction tactics [25]. HCI is becoming more integrated in fields like as entertainment, education, and healthcare. Generally used application fields include integrating HCI into the workplace, electronic business, group collaboration, culture and

globalization, client learning and preparation, framework improvement, and medical services. The widely acknowledged components of the interaction will be the major emphasis of this research.

HCI Devices
A wide range of devices function as user and computer interfaces.

Discrete input via a keyboard
Connected keyboards tied to computers, terminals, or workstations are one of the most frequent forms of input devices now in use. The majority utilize a "QWERTY" keyboard layout, which is akin to a typewriter and contains extra keys for moving the cursor, inputting numbers, and other functions [26].

Continuous Input through Mouse
For continuous hand input, a much larger range of devices is used. Several studies and taxonomies [Foley et al. 1990; MacKinlay, others 1990] [26,27] have attempted to categorize this vast array of possibilities.

Voice
The user's speech provides another sort of input. Because speech is a robust, continuous process that requires user attention, it is the most effective form of communication [28]. Current technology breakthroughs allow you to speak with a machine in the same way that you would with a person. A few examples of voice recognition gadgets include Amazon's Alexa and Apple's Siri, which are the created inventions in speech recognition devices. The problem with natural language processing occurs if the computer can recognize all of the words in continuous speech [26].

Virtual Reality and Augmented Reality
In computer-produced simulation frameworks, a glove or other 3D hand input gadget is commonly used to enable the client to venture into and cooperate with the extended environment, as well as an appealing tracker to detect head movement and gap the virtual camera for scene presenting [27]. Expanded reality (AR) operates in the real environment with computerized goods, music, or other tactile information by utilizing technological breakthroughs [29]. Augmented reality applications include smart glasses, medical imaging, entertainment apps, navigation, and sensor detection.

HCI Related Statistics
HCI's fundamental idea is to provide safe, user-friendly, and effective technology to individuals of all abilities, experience, and expertise. To the greatest extent possible, people with disabilities shall be able to utilize any system developed utilizing HCI user-centered approaches and concepts. The adoption of HCI principles and user-centered design has significantly increased in various industries, including healthcare, education, finance, and technology. Many companies have realized the importance of delivering user-friendly products and services [30].

The Essential Components of HCI
HCI, as the name implies, is made up of three parts: user, system and their interconnection as mentioned in [31,32].

User
The term "user" refers to an individual client or a group of clients who work together. The system is used by the user in accordance with their planned duties. It may vary from person to person. Understanding how people's senses of sight, hearing, and touch convey information is essential.

Computer
A broad variety of technologies, ranging from small desktops to massive computer systems, are referred to as "computers." If we were looking at a site's layout, we may refer to the site as "the PC" in our conversation. "Computers" include cell phones, desktops, and VCRs.

Interaction

Individuals and machines have distinct characteristics. HCI, on the other hand, goes to great lengths to ensure that they get along and operate well together. Utilize your understanding of both humans and computers to craft a viable system, and engage with end-users consistently throughout the design phase. In practical scenarios, time constraints and budget considerations hold utmost significance, underscoring the need to find equilibrium between user requirements and practical implementation. The realm of human-computer interaction (HCI) comprises three interconnected elements: a computer, an individual, and the dynamics of their interactions. People leverage computer capabilities to accomplish an array of tasks. A means through which users can interact with a system is recognized as a computer interface, a pivotal aspect within this field.

Principles of HCI

The eight guidelines are referred to by Shneiderman as the "golden rules." HCI is founded on four essential principles. Behaviour, perception, and descriptive modelling are all examples of models. The book "Designing the User Interface" by Ben Shneiderman is the source. Shneiderman assembled a collection of key user interface principles and ideas. These concepts may benefit any well-designed user interface.
Each of the 'Golden Rules' [33] is listed below.

1. Attempt consistency
2. Enable typical customers to use alternate routes
3. Provide instructional critique
4. Plan exchange to produce
5. Provide uncomplicated error handling
6. License simple inversion of activities
7. Support within the locus of control
8. Decrease brief memory load

Middleware Support for HCI

The point at which humans and machines communicate in human-computer interaction through an interface is called as user interface (UI). A Human-Machine Interface (HMI) is made up of layers that connect machines to actual information devices such as consoles, mice, gaming pads, and result items such as PC screens, speakers, and printers. A Human Interaction Gadget (Stowed) is a device that performs a Human-Machine Interaction (HMI). The following are additional levels of user interfaces (UI) that interact with one or more human senses:

1. Tangible UI (touch).
2. Viewable UI (sight).
3. Phonic UI (sound).
4. Odoriferant UI (smell).
5. Equipoise UI (balance).
6. Gustative UI (taste).

UIs that function with two or more senses is known as Composite user interfaces (CUIs). The Graphical User Interface (GUI) stands as the most widespread CUI, seamlessly blending visual and tactile elements to present graphics. On the other hand, a Multimedia User Interface (MUI) takes it a step further by incorporating sound into the Graphical User Interface, enhancing the user's experience. CUI comes in three varieties: standard, enhanced, and virtual. A typical CUI employs human-computer interface devices such as consoles, mouse, and computer screens. A virtual reality interface is utilized when the actual environment is sieved out. When the CUI does not totally shut out the natural environment then Augmented Reality is used. Within the realm of Human-Computer Interaction (HCI), middleware assumes a crucial role by facilitating smooth interactions between users and digital systems, leading to enhanced user experiences and improved system performance [33].

Factors in HCI

There are some intriguing elements to consider while utilizing HCI standards to break down and grow a framework. The following are the most fundamental elements. Here are some important factors in HCI [34-39].

Usability

Usability stands as a cornerstone in HCI, guaranteeing that interfaces are readily graspable, operate with efficiency, and deliver a favorable user experience.

User Experience (UX)

User experience goes beyond usability and considers users' emotions, attitudes, and perceptions during interaction with technology.

Accessibility and Inclusivity

Ensuring that interfaces are accessible to users with disabilities and diverse needs is crucial in HCI design.

User-Centered Design

User-centered design entails engaging users within the design process and customizing interfaces to align with their needs and preferences.

Cognitive Load

Understanding users' cognitive load during interaction is essential for designing interfaces that are cognitively efficient and reduce mental burden.

Error Prevention and Handling

The implementation of proficient error prevention and handling mechanisms holds vital importance in minimizing user frustration and enhancing system reliability.

Visual Design

Visual design considerations, such as aesthetics and layout, play a significant role in user engagement and satisfaction.

Goals of HCI

To discover how to create user-friendly interactions and interfaces is the intention of HCI. As a consequence, we will obtain information [34-39].

1. Understand User Needs
2. Improve Usability
3. Enhance User Experience
4. Ensure Accessibility and Inclusivity
5. Optimize task performance
6. Support User-Centered Design
7. Address Ethical Concerns
8. Adapt to user context
9. Evaluate and improve Interfaces
10. Keep pace with emerging technologies
11. Facilitate collaborative interactions

Challenges in HCI

There are several challenges in HCI that researchers and practitioners face. Below are some of the key challenges in HCI [34-40].

Usability and User Experience

Ensuring that interactive systems are usable and provide a positive user experience is a fundamental challenge in HCI. This includes designing interfaces that are intuitive, efficient, and enjoyable for users.

Accessibility and Inclusivity

Making interactive systems accessible to all users, including those with disabilities, is a significant challenge in HCI. Ensuring that interfaces are inclusive and accommodate diverse user needs is essential for equitable technology use.

Privacy and Security

Protecting user privacy and maintaining the security of personal information within interactive systems is a pressing challenge. Users must feel confident that their data is safeguarded and used responsibly.

Cognitive Load and Information Overload

Designing interfaces that minimize cognitive load and prevent information overload is a challenge, as users have limited cognitive resources to process information.

Multi-Platform and Cross-Device Interaction

With the proliferation of various devices and platforms, ensuring seamless interaction across different devices is a significant challenge. Designing interfaces that adapt to different screen sizes and interaction modalities is crucial.

Research Gaps

Professionals and scientists in the Human-PC Collaboration (HCI) convenience component and programming (SE) have lately begun to connect these two domains in a number of scenarios. HCI believes that by bringing this essential work to CHI, it will be continued and that academics and practitioners will be included in all elements of UID, such as usability, SE, Interface plan, similitude plan, route plan, mental model plan, and visual plan are all examples of plans. In view of authentic contextual analyses of professional and amateur researchers, it was found that:

1. people collaborate when there aren't enough instances of each other's work, and
2. people collaborate when there aren't enough good examples of each other's work.
3. Effective collaboration requires the use of diverse analytical units, data aggregation methodologies, and abstractions.
4. work together despite having different audiences, aims, timetables and staff.
5. Gaining insight into the process of designing and adapting user interfaces for emerging technologies like virtual reality (VR), augmented reality (AR), and wearable devices.

Traditional Medicine Fundamentals

This section discusses definitions of traditional medicine, its features, types, and classifications. It emphasises features or characteristics, types of various countries and classifications, levels of Traditional medicine and their combinations in the healthcare domain. Traditional Medicine (TM), the oldest type of health treatment, is also termed as Complementary and Alternative Medicine (CAM). Some other terms are ethno medicine or folk medicine or native healing. People used such treatment procedure to deal with many ailments that endanger their survival. Physical and mental diseases can be prevented and treated with them [41]. Most countries like Asia, Europe and America use orthodox medicine, makes a vital part of healthcare. Examples are Chinese Acupuncture and Indian Ayurveda medicines. Traditional Medicines are readily accessible and reasonably priced, and accessible to most people, even in remote locations [41]. Diverse cultures have developed over time. A traditional healer is an individual acknowledged by their local community as possessing the expertise to provide healthcare services utilizing substances from plants, animals, minerals, and other methods rooted in social, cultural, and religious traditions [42]. The majority of Traditional Medicine (TM) drugs are formulated using common ingredients. Clinical trials within the realm of TM have been conducted since its inception. The utilization of TM has proven advantageous for modern medical practices. TM holds an edge over other forms of medicine due to its reliance on natural components, spanning areas like the discovery of lead compounds and potential medications, the assessment of drug-like effects, and the investigation of

physicochemical, biochemical, pharmacokinetic, and toxicological aspects. If effectively harnessed, TM could potentially contribute to the advancement of new drugs, resulting in various benefits, including substantial cost savings [43]

Traditional Medicine-Related Fundamentals
Traditional Medicine – Definition
According to the World Health Organization (WHO), "traditional medicine encompasses a diverse array of knowledge, skills, and practices originating from the specific theories, beliefs, and experiences of different cultures. It serves the purpose of promoting health and preventing, diagnosing, improving, or treating physical and mental illnesses" [44]. Traditional medicines (TMs) rely heavily on natural ingredients and are extremely valuable [43]. Folk medicine is a phrase used to characterize practices that accompany among organized, evidence-based, institutionalized approach of therapeutic practice symbolized by alternative medicine in many nations [45]. Folk medicine medical traditions include Traditional Chinese medicine, Conventional medicine of Korean, Arabic native medical practices, Uyghur medical practices, Japanese Kamp medical practice, Bush aboriginal medical procedures, Native Lau lapaau of Hawaii, and Georgian traditional medical practices [46].

Traditional Medicine Features
Due to the more expensive nature of contemporary scientific health care, traditional medicine serves a vital complementary role in the delivery of healthcare and its use is on the rise. Traditional medicines (TMs) are very important and use natural ingredients. Products and procedures that have been developed over many years of practice, continuous experimentation, and finally integrating into a wide range of human experiences are referred to as TM [47,48]. Traditional medicines are readily available and reasonably priced, especially in rural locations, and are typically accessible to the majority of people. Even though they contain shortcomings in their many incarnations, they remain a vital source of human knowledge. Natural goods have been utilized for a long time and are critical in the creation of new drugs. Natural ingredients have greatly benefited several types of pharmaceuticals, including those used to treat cancer, hypertension, and migraines. [49,50].

Most commonly used Traditional Medicine Types and Schemes
Traditional Chinese Medicine

The effectiveness of medicine is the secret to its success. A famous Chinese saying states, "Excellence is from experience" [66]. TCM (Traditional Chinese Medicine) evolved over decades and decades of time. TCM was the major healthcare system in the country until the eighteenth century [66]. TCM has a wealth of knowledge and is founded nearly 5 millennia for medical practice and experience, ensuring the efficacy and value of its "clinical trials." TCM clinicians utilize a wide range of cognitive and/or tangible treatments (namely tai chi, acupuncture) and herbous medications to address health conditions [67].
 Types of Traditional Chinese Medicine

Acupuncture

Acupuncture is another alternative treatment and the subset of Chinese Traditional Medicine which is most frequently used to relieve pain, and it can also be used to treat a variety of other illnesses. Usually, acupuncture is used in conjunction with other types of therapy [68]. During acupuncture treatments, skin-piercing fine needles are introduced into the body. It might also include the use of heat, pressure, or laser light [69]. In 2017, the worldwide acupuncture market was valued at $24.55 billion USD. Europe had 32.7% of the market, followed by Asia-Pacific (29.4%), the Americas (25.3%), and the outside world. Over the year 2023, the sector remains anticipated to be valued $55 billion [70].

Moxibustion

In Traditional Chinese Medicine, a category of external therapy by burning mug wort leaves (a traditional Chinese herbal) or moxa wool on acupuncture points also called as acupoints is called Moxibustion. For more than 2.5 millennium years, moxibustion is used to detoxify channels and balance qi-blood that treat and prevent diseases. A significant scale of diseases can be treated by moxibustion. According to a scholarly review of studies published in China between 1954 to 2007 expose to cure nearly 364 forms of ailments with moxibustion. Some of the most relevant signs of moxibustion are diarrhoea, colitis, tissue injury, heel pain, asthma, age and weakness. It can be categorised into three classes [71,72].

1. Traditional moxibustion
2. Drug moxibustion
3. Modern moxibustion

Tui-Na Massage

In Eastern traditions, Tui-Na massage therapies have been used extensively for more than 4000 years. It is the ancient therapy system that comes under the category of Traditional Chinese Medicine. The combination of the body's energy and manual massage is applied in Tui-Na. As a traditional therapy, it is highly eminent at easing the way for muscles, tissues and bones and for aiding movement of joints. Therapists use this kind of healing energy (also called Qigong) using their hands in the points of muscles and bones. Tui-Na is highly aggressive and extremely active and relies on the needs of the treatment and approach of the therapist [73,74].

Cupping therapy

An age-old healing technique presently used to treat a large number of health disorders by applying cups to specific locations on the skin while providing pressure through heat or suction is known as cupping. The cups is made of glass, bamboo, silicone and brass. This traditional procedure is practiced throughout the world for curing of range of diseases like lack of appetite, poor digestion and headache, anxiety, depression and high blood pressure [75,76]. The two major types of cupping techniques are:

1. Wet cupping – non-invasive with no bloodletting
2. Dry cupping – invasive with bloodletting [77].

Tai chi

Tai-chi is a traditional Chinese healing/martial and therapeutic practice that integrates martial skills with Qi (vital energy) techniques. It is a practice with a sequence of slow, soft physical postures and a peaceful state of mind with yogic breathing. It is frequently referred to as "meditation in motion". The effectiveness of this mind-body technique, which is evolved in China, treats a variety of health conditions and psychological issues like depression, anxiety, stress, and mood disorders, as well as enhances balance, aerobic capacity, muscular strength, and flexibility. By using its biological and emotional advantages, it improves the standard of life for several kinds of people. Over the course of evolution, Tai-chi has transformed into five distinct styles, namely Chen, Yang, Sun, Wu and W'u [78,79].

Herbal medicine

One of the underlying vital methods of Traditional Chinese Medicine is Chinese herbology (Chinese herbal products) which includes major varieties of Therapies for medical issues such as coronary artery disease, stroke, psychological disorders, and respiratory problems. According to a nationwide poll, about one in every five Americans uses Chinese herbal treatments. Almost 100,000 medical formulae are preserved in ancient Chinese literature, and there are over 13,000 different medicines are utilized. The majority of materials used to treat are plant components and extracts. [80,81].

Traditional Indian Medicine

Ayurveda

Ayurveda is the most ancient traditional healthcare medicine and has a history of 5000 years old science. It is elicited out of the Sanskrit phrase "Ayur", which denotes "life", plus "Veda" which denotes "knowledge." Ayurveda is a medical science that focuses on the human life cycle and the meaning of life. It gains a profound understanding of the physical, mental and emotional level of an individual combined with nature. With this collective intelligence, we can discover the activities, circumstances, herbal products and nutrients which keep our health balanced one. One of the distinct aspects stated in Ayurveda is Prakriti which is called three doshas. 1.Vata 2. Pitta 3. Kapha Prakriti is governed by a single dosha or a mixture of two or three doshas. We can analyse the disease by examining the Prakriti that determine the unbalanced dosha in the body. The Tri-Doshas in an individual cooperate to maintain homeostasis over the course of their existence, beginning with fertilisation. Each Dosha has been given unique attributes and roles. For instance, Vata is involved in the manifestation of shape, cell division, signalling, movement, waste excretion, and cognition, and it also controls Kapha and Pitta's functions. Kapha is in charge of anabolism, growth, and the upkeep of stability, storage, and structure. The primary functions of Pitta are host surveillance, pigmentation, vision, energy balance, metabolism, and thermoregulation[82-84].

Yoga and Naturopathy

Nearly a three millennium-old tradition aiming to balance and improve a person's physical, mental, emotional and spiritual well-being is called Yoga. It was elicited from the Sanskrit word "yuj", which denotes yoga signifies unification, to unite as well as to focus and guide one's concentration. It is a type of mind-body exercise that incorporates physical workouts with an Inner conscious attention on self-awareness, breath, and energy. Patanjali introduced yoga theory and practise for the first time in the classic literature, Yoga Sutras, which is widely regarded as the canonical source on yoga. The frequent habit of yoga stimulates qualities of openness, empathy and self-discipline and also boosts stamina, endurance and agility [85,86].

Yoga comprises eight phases as described in [87].

1. Asanas
2. Pranayama   Samadhi
3. Pratyahara   Yamas
4. Dharani   Niyamas
5. Dhyana

Unani

Ayurveda, Unani, Siddha, Homeopathy, Yoga and Naturopathy are all traditional Indian medical systems acknowledged by the Ayush Ministry. The In dian Government has included Unani medicine as part of its national healthcare system. With increased research, Unani medicine is gaining popularity outside of South Asian countries like Bangladesh, India, Pakistan and Iran, where it is now a regular part of the medical system. One of the oldest medical systems, the Unani System of Medicine, focuses on maintaining health, treating illnesses, and re-establishing a healthy lifestyle. With a comprehensive approach, it delivers healthcare that is preventive, promotive, curative, and rehabilitative. This system's basic tenets are founded on scientific ideas, such as the Hippocratic doctrine of the four senses of humour:

1. Safra (Yellow Bile),
2. Dam (Blood),
3. Sawda (Black Bile).
4. Balgham (Phlegm),

The 'Six Essential Factors' stated below are not only utilised for sustaining wellness along with disease prevention, but also for disease treatment. [88,89]

1. Air
2. Diet (food habits)

3.   Body activity and repose
4.   Psychic activity and serenity
5.   Sleep and attentioness
6.   Withholding and elimination

Siddha

A system of traditional medicine known as Siddha Medicine has its roots in ancient Sri Lanka and Tamil Nadu in South India. According to conventional wisdom, the Siddhars provided the groundwork for this medical system. The master of all Siddhar and the first Siddhar is thought to be Agastyar. According to the Siddha procedure, the human anatomy is made up of trio humours as well as seven fundamental constituents. The three tri-humours are:

1.   Vatham
2.   Pitham
3.   Kapham

provide life to the human body. Over the world, many different traditional systems are in practice. The Government of India's Ministry of AYUSH is authorized for the Siddha system. Other nations, including Malaysia, Singapore, and Sri Lanka, also practice Siddha medicine.   The Siddha system is helpful in treating all acute and chronic ailments through thousands of plants and minerals incorporated with it. While its therapeutic procedures are focused on dietary changes and lifestyle adjustments, the Siddha system is also known as the "science of longevity." [90]

Homeopathy

A homoeopathy is a form of treatment that makes use of formulations of chemicals whose effects, when given to healthy persons, correlate to the symptoms, clinical signs, and pathological conditions that the particular patient experiences as a result of their particular ailment. Samuel Hahnemann (1755–1843) created the technique, which is today used all around the world [91]. The three main ideas in homoeopathy were referred to as a triade (Fig. 1). These three ideas form a triangle, with complexity and individuality, similarity and dilutions as its vertices (clockwise from the top).

Phases of Traditional medicine

In order to attain the minimized time, cost and toxicity the 3 different phases are used. They are [92]:

Observational phase

This is the first phase in which the various scientific observations which are robust in nature are documented. These are the previous findings or experiments which are implemented successfully through clinical trials followed by proper guidelines and policies to document.

Investigation phase

This is the middle phase after the observational phase. This phase ensures the capability, dosage range in patients, the interval between doses and determining the focus activity using vitro and vivo tests (a lab test).

Experimental/Testing phase

This is the last phase of levels of traditional medicine. This is the study phase of the basic and clinical trial research activities. These three phases combinedly drives the discovery of traditional medicine.

Traditional Medicine Design Principles

There are various design principles to be considered for Traditional Medicine.
1.   Selection and Identification
2.   Screening process
3.   Clinical trials
4.   Standardization

5.   Quality control
6.   Regulatory Affairs and Guidelines

Traditional Medicine Life Cycle
Levels of Traditional Medicine
Diagnosis
The first step towards the Traditional Medicine life cycle is Diagnosis. Finding the causes of an illness is part of the diagnosing process. Detection of the various factors involves checking the pulse, the urine, the eyes, the voice, the colour of the body, tongue along with the digestive system condition. The Siddha medical procedure has developed the specialized examining method of urine that includes examining its colour, odour, density, amount, and pattern of oil drop spreading. This method not only provides illness diagnoses but it also provides prognosis information. Several diagnostic techniques are used in the Siddha system. One of the diagnostic tools is Manikadainool. A patient's wrist circumference is measured using an inelastic thread, the measurement is expressed in the patient's own finger breadth units, and the result is used to interpret a prognosis or diagnosis of a condition [93].

Pulse Change
Pulse diagnosis is used to diagnose health ailments in Traditional Indian medicine. The foundation of pulse diagnostic is based on three radial pulses.
1.   Vatha
2.   Pitha
3.   Kapha
These 3 pulses can be able to diagnose the diseases in the human body [94].

Treatment
Treatment of diseases can be given according to pulse classification based on the Pulse changes.

Life cycle stages
The life cycle of traditional medicine typically involves several stages, from its historical origins and development to its integration into modern healthcare systems. Each stage plays a crucial role in shaping the use and acceptance of traditional medicine. Below are the common stages in the life cycle of traditional medicine [95-100].

Historical Origins and Traditional Knowledge
Traditional medicine has its roots in ancient practices and knowledge passed down through generations. This stage involves the historical development of traditional medicine systems based on cultural beliefs, observations, and experiences.

Ethnobotanical and Ethnopharmacological Studies
Ethnobotanical and ethnopharmacological studies examine how medicinal plants and traditional remedies are used by different indigenous communities. These studies provide valuable insights into the therapeutic properties of traditional medicines.

Documentation and Traditional Medicine Systems
This stage involves the documentation of traditional medicine practices, knowledge, and treatment methods. It helps preserve and disseminate traditional medical knowledge for future generations.

Integration into Modern Healthcare
In this stage, traditional medicine may be integrated into modern healthcare systems, either as complementary or alternative therapies. Governments and health organizations often regulate and standardize traditional medicine practices during this phase.

Research and Evidence-Based Validation

As traditional medicine gains recognition, there is increasing emphasis on conducting scientific research to validate its efficacy, safety, and potential interactions with modern medicine.

Education and Training

To guarantee the safe and effective utilization of traditional medicine, educational and training programs are essential and are developed for practitioners and healthcare providers. These programs aim to enhance knowledge and skills in traditional medicine practices.

The definition and idea of Naadi (Pulse)

The ultimate diagnosis of the disease is determined by Naadi's evaluation and is based on Yen vagaithervu. The only things in the Naadi are vatham, pitham, and kabam. The word "Naadi" is Thathu. It displays the blood vessels' pulses (arteries & veins). The heart and the Naadi (Pulse) are connected. Naadi (Pulse) allows us to investigate how the heart works [6]. The alignments of the afflicted outrageous determine the course of treatment, so mukkutram (vatham, pitham, kabham) is a crucial diagnostic characteristic. Similar to how naadi, neerkuri, and neikuri are founded on kutrams, so are other crucial parameters [94,95].

Thathukkal, Ezhuudal:

1. Saaram
2. Khozhuppu
3. Oon
4. Naatham
5. Senneer
6. Enbu
7. Moolai
8. Vinthu

Existing research Prototypes and Systems in Traditional medicine

Sensors, Technology and Device Findings for Traditional Medicine

Optical Sensor

The pulse has been used in traditional Indian medicine as a method of disease diagnosis. The three radial pulses known as vata, pitta, and kapha constitute the foundation of this pulse diagnostic. A *photoplethysmographic sensor* for pulse diagnostics is presented in this study. The blood flow rate is monitored using a PPG sensor. The sensor is positioned at the vatta, pitta, and kapha-corresponding determined radial locations. Lab VIEW software is used to analyse the sensor's output.PPG measurements are made at the wrist of subjects in various age groups. The subject's vata, pitta, and kapha types are determined by comparing the obtained PPG signal to the values recorded by the Siddha Practitioner [93].

Electronic nose

E-nose technology outperforms traditional analytical methods such as gas chromatography-mass spectrometry (GC-MS) in terms of its user-friendly nature, high sensitivity, real-time detection capability, and non-destructive attributes. Although E-nose techniques have been extensively developed in various other fields, their application in the quality control of Chinese Herbal Medicine (CHM) has received limited research attention. The current study seeks to investigate the practical benefits of E-nose technology in the reliable and effective detection of aromas within CHMs. It employs E-nose technology to explore the impact of diverse factors, including cultivation locations, identification strategies, manufacturing processes, and storage durations, on CHMs. Furthermore, the study addresses the challenges and potential advantages associated with employing E-nose technology for the identification of CHMs. As technology continues to advance, odor detection through E-nose technology could potentially emerge as a novel quantitative parameter for ensuring the quality control of CHMs and the development of pharmaceuticals. However, a more extensive inquiry is necessary to comprehensively evaluate its potential and utility in this particular domain [101].

Sensor Based Classification and Evaluation Methods using Machine Learning Algorithm

The hardware configuration suggested in this research encompasses a Raspberry Pi 3b, linked to multiple sensors such as a camera, color sensor, moisture sensor, and pH sensor. The primary aim of this configuration is to employ machine learning algorithms like Support Vector Machine (SVM) and Random Forest (RF) for color value classification and identification of "Churnas." Upon carrying out experimental trials, the findings indicate that the RF Classifier exhibits superior performance compared to the SVM Classifier in terms of accuracy, sensitivity, and specificity when distinguishing the attributes linked to Churnas [102].

IoT Based Automatic Medicinal Herbs Monitoring and Controlling

Based on ecological reasonableness, agronomic efficiency, calculated suitability, and quality appropriateness, a strategy for establishing acceptable maps for medicinal herbs can be developed and implemented. However, these plants' growth is essential for the preservation of their natural populations. Therefore, indoor climate observing and control might be found anyplace, from open working environments to private homes. This strategy aims to develop an automated framework for monitoring medicinal herbs through sensing and automation. The fixation of carbonic corrosive gases in internal environmental variables would be balanced out by a massive plant divider framework, as previously demonstrated by research. This would effectively reduce the groups of stuff and unexpected natural mixes. This article presents a plant-explicit remote review and controlling structure. The framework modifies the administration system, increases quantifyability, enhances plant division customer experiences, and adapts the unpractical interior environment by utilizing open cloud stages and IOT innovation [103].

Traditional Chinese Medicine modernization for Biosensors application

Bio sensing technology has helped fundamental studies of traditional Chinese medicine (TCM) as well as its targets, separation and purification, mechanism, quality control, and active component detection. Biosensor technology has become a hotspot for future research and has made a significant contribution to current herbal medicine research [104].

Indian Traditional Medicine Methods: Siddha Diagnosis Methods-Traditional way

Diagnosis still relies heavily on traditional Siddha diagnostic methods. The diagnostic method of the Siddha system stands out because it diagnoses not only ailments but also their potential causes. The eight diagnostic procedures handed down by the Siddhars are referred to as **EnvagaiThervu**[105].

Naa (Tongue)

The tongue-related signs and symptoms are taken into consideration. The tongue's thickness, coating and patches, longitudinal and transverse tongue fissures, taste sensation, and saliva production are all considered. Oral aphthous ulcer, oral hairy leukoplakia, oral candidias is, and other conditions may be identified by examining the tongue.

Mozhi (Speech)

The Siddha practitioner notices clearly the difference in the change of actual sound of the voice, the pitch and the tone of the voice. While in conversation with the patient, the behavioural and mental status is also observed and indicated.

Niram (Color)

The skin color is indicated in the color tool. The color may be dark in vatham, yellow or red in pitham and pale in kapham.

Kan (Eye or Sight)

The variables considered include the shade of the eye, warmth in the eye, a devouring feeling, disturbance in the eyes, visual discernment, and so on.

Sparism (Touch)

Warmth, sensory impairment, skin texture, pain, hardness, and dullness are all measured when the patient is touched as part of the diagnosis. During contact, physical anomalies such as lumps, nodes, and edematous or common swellings are seen.

Malam (Stool)

The amount, hardness (difficulty in moving), colour, and odour of the patient's excrement are all evaluated.

Siruneer (Urine)

The patient's urine is monitored and collected for investigation in the early morning. If a urine test reveals any of the following characteristics: tone, amount, explicit gravity, scent, frothy quality, or stores. In general, saffron-colored urinating indicates jaundice, straw-coloured urine, constipation, and reddish-yellow urine, excessive heat. The Neykuri Analysis is yet another unique diagnostic process used only by Siddha Medicine. A fresh sample of a few drops of early morning urine is acquired using this unique process. A little amount of sesame oil has been applied to the surface of this sample. The oil spreads throughout the urine test, displaying various instances for each individual.

Naadi (Pulse)

When the index and middle fingers are united and softly placed on the blood artery below the thumb, pulse beats can be felt. A person's heart rate or pulse rate may be measured and felt by everyone. Only a trained Allopathic or Siddha practitioner, however, can detect disorders based on the rhythmic patterns of the pulse. The degree of distortion or rhythmic shifts in a vatham, pitham, and kapham pulse can usually be interpreted by skilled Siddha practitioners. *Modern diagnosis methods involve blood tests and scan reports.*

Pulse Diagnostics

Three humors or thathuvams are associated with Vali (air), Azhal (fire), and Aiyam (water). These humors are called Vatham, Kapham, and Pitham. These three humors constantly interact with the five fundamental elements of the outside world or the cosmos to determine the state of the body and mind [93]. For a sickness free, solid presence, the proportion between the three should be kept consistent at 4:2:1. The three humors—Vatham, Kapham, and Pitham— are believed to cause illness or ill health when disturbed [94]. Siddha claims that if the three humours are interrupted, the seven essential physical components of the human body—namely, Enbu (Bone), Saaram (Chyle), Kozhuppu (Fat), Moolai/Nalli (Marrow), Senneer (Blood), Oon (Muscle), and Sukkilam/Suronitham (Sperm and Ovum)—are also impacted. The Siddha Medical system also believes that food is a medication, according to the Unave Marunthu idea. According to this logic, any dish with a high concentration of one Suvai (taste) is considered to upset the three humours. Sweeter meals, such as sweets, are more detrimental than good. Simply defined, Siddha Medicine believes that the environment, climate, nutrition, physical activity, stress, and other variables all have a part in illness formation. (AIR) VALI Space and air have an impact on Vatham, also known as Vali.FIRE (AZHAL) Azhal and Kapham are affected by fire and water. WATER (AIYAM) Aiyam, or Pitham, is affected by the elements of earth and water. The five primal elements of nature—Earth, Water, Air, Fire, and Space—must coexist with the three humours. Changes in the responses of three thathuvams to these five early stage components might cause discord. Disease and illness come from the changed harmony and imbalance of the three thathuvams [91,93,94]. Pulse diagnosis is an essential diagnostic technique used in Siddha medicine, a traditional system of medicine that originated in ancient South India. In Siddha medicine, the pulse is considered a valuable source of information about the state of the body's health and the balance of its vital energies or doshas (known as Vata, Pitta, and Kapha) [91]. Here's how pulse diagnosis works in Siddha medicine [91,93,94]

Location

In Siddha medicine, the pulse is typically felt at the radial artery on the wrist. Practitioners use three fingers (index, middle, and ring fingers) to palpate the pulse gently.

Interpretation

The practitioner observes various factors while feeling the pulse, such as the rhythm, speed, strength, and overall qualities of the pulse. They also pay attention to the presence of any specific sensations, such as throbbing or irregularities.

Dosha Assessment

Siddha medicine is based on the concept of doshas, which are the fundamental energies or humors that govern the body's functions. The pulse diagnosis helps the practitioner determine the balance or imbalance of Vata, Pitta, and Kaphadoshas.

Subtypes of Doshas

Within the three main doshas, there are several subtypes. The pulse diagnosis helps identify the specific subtype of each dosha that might be affected.

Disease Diagnosis

Based on the pulse findings and the dosha assessment, the practitioner can identify the presence of any imbalances or diseases in the body.

Individualized Treatment

Siddha medicine emphasizes individualized treatment approaches. Once the practitioner determines the dosha imbalances, they tailor the treatment plan to bring the doshas back into balance. This may include herbal remedies, diet recommendations, lifestyle changes, and therapeutic practices.

Follow-up

Pulse diagnosis is not a one-time event but an ongoing process. The pulse is regularly monitored throughout the treatment to assess the progress and adjust the treatment plan accordingly.

Manikkadainool

Anthropometry is the study of the methodical measuring of the person body, its dimensions in particular. Thread measures are used in Traditional Siddha Medicine to quantify wrist circumference measurement through the number of fingerbreadths of the same person. This idea of measurement is based on its interaction with a variety of elements, such as the individual's fundamental diet, psychological circumstances, environmental and seasonal impacts, and illnesses. For successful expectations and conclusion, spellbinding components of separate finger input received are connected among the clinical image of an individual [93,109]. The unique diagnosing method for diseases was said in Agaththiyarsudaamanikairu suththiram also phrased as Manikkadai Nool. Sage Agathiyar produced the book SoodamaniKayaruSoothiram in Siddha medicine, the number of Finger Breadths is used to make diagnostic predictions by measuring a person's wrist circumference. eleven finger width inputs offer a total of 26 finger measures with sub divisions of 1/4, 12, 34, and full FB [90,108]. Manikkadainool, according to Pathinen Siddhar Naadinool, is also useful for diagnostics. This Manikkadainool is used to diagnose the ailment by measuring the wrist circumference with a thread and dividing the result by the patient's fingers. This measurement can be used to make a diagnosis. When he reaches 11 FB, the Manikkadainool will be powerful and enjoy a long and healthy life. When the Manikkadainool score falls between 4 and 6, the disease's prognosis is bad, and the condition is severe enough to cause death [90,93,110,111].

Human–computer interaction approach for Traditional healthcare

The most worthwhile medical system in China is the TCM. The applications of TCM is examined by utilizing in computing technology. The integration of the computing technology and TCM will asisst to the modernization of TCM foster the international standard [112]. Traditional Healthcare has its benefits over a long period of time. The medicine's quality, safety, and efficacy of dose are the current level of information falls short in meeting the demands necessary for global application. There is also an inadequate description and lack of standardization in terms of adverse effects and treatment methodologies. Despite the fact that certain systems, such as Ayurveda and Traditional Chinese Medicine (TCM), have undergone rigorous testing, in-depth scrutiny of Traditional Medicine formulations remains uncommon. Both the healer and the patient actively participate in the healing process. In contrast, modern medicine adheres to thorough standardization, possessing a structured system with comprehensive details on precautions and adverse effects. The safety, efficacy, and quality of medicines are firmly established, and their mechanisms of action are well comprehended. Practitioners also undergo substantial training, while patients are required to collaborate in the diagnosis, treatment, and follow-up by adhering to prescribed medications. [113,114,115].

PROBLEMS NEED TO BE ADDRESSED

Traditional medicine, despite its significance and widespread practice in various regions, encounters several challenges and concerns that must be tackled to ensure its responsible integration into modern healthcare systems and to harness its full potential benefits. Some of the primary issues faced by traditional medicine are as follows [116]:

Insufficient Scientific Validation

A prominent challenge for traditional medicine lies in the lack of substantial scientific validation and evidence-based research supporting the effectiveness and safety of numerous traditional treatments. To gain acceptance within modern healthcare, traditional medicine should undergo rigorous scientific scrutiny through comprehensive studies and research.

Quality Control and Standardization

The quality and potency of herbal remedies and traditional treatments can vary significantly, as there is often no standardized manufacturing process. Ensuring consistent quality and safety across traditional medicine product is essential.

Intellectual Property Rights

Traditional knowledge, including medicinal plant information and treatment methods, is vulnerable to misappropriation and exploitation. Protecting the intellectual property rights of traditional healers and indigenous communities is crucial to prevent the unauthorized commercialization of their knowledge.

Regulation and Licensing

In some regions, traditional medicine may lack proper regulation, leading to unqualified practitioners offering treatments without adequate training. Establishing regulatory frameworks and licensing requirements is essential for ensuring patient safety.

Integration with Modern Healthcare

Integrating traditional medicine into mainstream healthcare systems can be challenging due to differences in terminology, diagnostic methods, and treatment approaches. Finding ways to bridge the gap between traditional and modern medicine is essential for collaborative patient care.

Safety and Side Effects

Certain traditional remedies have the potential to interact with modern medications or produce adverse effects if not administered properly. Educating both practitioners and patients about these potential risks and ensuring their appropriate usage is essential.

Cultural Sensitivity

Traditional medicine has its foundations deeply embedded in cultural and spiritual beliefs. Therefore, it is of utmost importance to approach its integration into modern healthcare with cultural sensitivity and a profound respect for the diverse traditions and practices it entails.

Education and Training

Enhancing the knowledge and skills of traditional healers through proper training and education is crucial. By incorporating modern medical concepts and evidence-based practices into traditional medicine training, its effectiveness can be significantly improved.

Access and Affordability

In certain regions, traditional medicine proves to be more accessible and cost-effective than modern healthcare. Nevertheless, in other areas, access to traditional medicine may be limited. Ensuring equitable access to traditional medicine for all communities is of utmost importance.

Sustainability and Conservation

The overexploitation of medicinal plants and natural resources for traditional medicine can threaten biodiversity. Promoting sustainable practices and conservation efforts is necessary for the long-term availability of medicinal resources.

Public Awareness and Education

Educating the public about the benefits and limitations of traditional medicine is crucial. Raising awareness can help individuals make informed decisions about their healthcare choices. Addressing these problems and issues requires collaborative efforts among governments, healthcare institutions, researchers, traditional healers, and communities. By recognizing the value of traditional medicine and working towards evidence-based integration, we can create a healthcare system that combines the strengths of both traditional and modern approaches to benefit individuals and communities worldwide.

Challenges and Future Research Directions

In the study presented above, we investigated the need for digitization of Traditional Healthcare in means of HCI technologies and applications. The gathered information of usual traditional medicine methods is lacking of accuracy, low frequent of reoccurrences, inadequate consistency, reliability and non-standardization. And to enhance this, HCI applications plays a major role in forming a digitization and modernization of traditional healthcare. The existing research improves step by step process of digitalization in data quality, data preservation, making regulations and standardization, design and development of prototypes of various modern devices, diagnosing of diseases using modern automated devices, data handling using Big Data and Machine Learning algorithms for traditional healthcare. The study has limitations which will be considered for future research work. The most important limitations are expensive in price, small quantity of sample data, inaccuracy and less reliability. Future research should focus on the cost-effective, getting more larger samples of data to examine, accuracy, standardization and high reliability. Taken altogether, the Indian Traditional Healthcare should be given extended importance in future research as compared to Chinese Traditional Healthcare as it is well-developed. By investigated the present article, we also extend our work on Manikkadainool as one of the oldest methods in diagnosing diseases in Indian Siddha Medicinal system. Secondly, the unawareness in computing technology, less short of knowledge, lack of specialists in technology and weak commitment are also its limitations. To gain keen interest with traditional medicine along computing technology can be resolved by conducting training sessions, lectures speeches, symposium, conferences, workshops, etc.

DISCUSSION AND CONCLUSION

HCI enables the creation of user-friendly interfaces that facilitate easy access to traditional medical knowledge, herbal remedies, and cultural health practices. Through mobile apps, telemedicine platforms, and digital records, traditional healers and patients can connect and communicate seamlessly, transcending geographical barriers and improving healthcare accessibility. The preservation and documentation of traditional medical knowledge are facilitated by HCI-driven efforts to create digital repositories and interactive archives. By safeguarding this invaluable knowledge, we ensure that it remains accessible for future generations and contributes to the sustainability of traditional healthcare systems. Furthermore, HCI enables collaboration and knowledge-sharing between traditional healthcare practitioners and modern medical professionals. Bridging the gap between these two systems fosters a better understanding of traditional healing practices and promotes the incorporation of proven and effective traditional remedies into modern medical treatments. However, while embracing HCI for traditional healthcare development, it is crucial to approach the integration with cultural sensitivity and respect for the unique values and practices of diverse communities. Ethical considerations, data privacy, and inclusivity must be at the

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forefront of design and implementation. In the pursuit of enhancing traditional healthcare through HCI, research, collaboration, and continuous feedback from users are essential. Governments, healthcare institutions, researchers, and communities must work together to create an ecosystem that nurtures the growth and evolution of traditional healthcare, ensuring its relevance and efficacy in the ever-changing healthcare landscape. Ultimately, HCI for traditional healthcare represents a remarkable opportunity to combine the wisdom of ancient healing systems with the power of modern technology. Embracing this synergy can lead to a future where individuals benefit from comprehensive, culturally sensitive, and effective healthcare solutions that respect and preserve the rich heritage of traditional healing practices. It should be emphasized that pulse diagnosis in Siddha medicine demands considerable experience and expertise. Siddha practitioners undergo extensive training to cultivate a profound comprehension of the pulse's intricacies and its correlation with the overall health of the body. While pulse diagnosis is a valuable tool in Siddha medicine, it is typically used in conjunction with other diagnostic methods to provide a comprehensive assessment of a person's health. In conclusion, Human-Computer Interaction (HCI) holds immense potential for revolutionizing traditional healthcare practices and advancing the integration of ancient healing systems into modern healthcare. By leveraging technology to enhance the interaction between humans and traditional medical practices, we can achieve a more holistic and patient-centered approach to healthcare. The constant pessimistic perspective is necessary to transform as portrayed by Western medicine towards conventional medicine in order to gain advantageous alliances. Numerous modern concepts and theories have been developed by many researchers related to computing technology in field of traditional healthcare system especially in Ayurveda, Siddha, TCM, and so on. Standardization and policy making process are very complicated in Traditional Medicine systems.

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Table 1.1: General Features of Various Major Traditional Healthcare Systems in Different Countries

Name of the Traditional Medicine	Developing Country	Characteristics	Types/methods used
I. Chinese Traditional Medicine (TCM) [51,52,53,65]	China	▪ According to the notion of Yinyangism (Yin and Yang) (water and fire) ▪ Basic concept is called Qi, which means vital breath surges through the body. ▪ 5000 years of medical practice and experience.	Acupuncture Moxibustion Tui-Na Massage Cupping therapy Tai chi Herbal medicine
II. Kampo (Traditional Japanese Medicine) [54,55,65]	Japan	▪ Originated in China, which is later adapted by Japan and modified according to its traditions and culture. ▪ Adapted and used nearly 1500 years ago. ▪ Integrated into modern medicine due to high quality and safety measures.	Mostly uses all the methods that are available in the Traditional Chinese Medicine system. ▪ Acupuncture ▪ Shiatsu – Japanese massage therapy ▪ Seitai – Japanese chiropractic
III. Koryo (Traditional Korean Medicine) (TKM), (hanyak) [56,57,65]	Korean	▪ Medicinal plants were used as remedial treatments like soothing pain or joint injuries in addition to nutrient foods which were beneficial at the time. ▪ Developed its own distinctive traditions and has absorbed those of other	▪ Herbal medicine ▪ Moxibustion ▪ Acupuncture

		• civilizations like wormwood and garlic which are not included before. ▪ Created their own medicine rather than using Chinese medicine as their model. ▪ Invented medications that was best suited to their genetic characteristics and way of life.	
IV. Traditional Aboriginal medicine [58,65]	Australia	▪ Complex system and have different cultures and approaches for health. ▪ Uses native Australian flora and fauna as medical plants. ▪ Also called as bush medicine.	▪ Ngangkayi ▪ Yawulyu ▪ Herbal Medicine
V. Traditional African Medicine [59,65]	Africa	▪ Based on spiritual aspects. ▪ Three phases of expertise make up the integrated health care system: divination, spiritualism, and herbalism. ▪ Includes a herbal therapy believed to have medicinal properties as well as symbolic and spiritual value.	▪ Divination ▪ Spiritualism ▪ Herbalism
VI. Iranian Traditional Medicine [60]		▪ Also called as Persian Traditional Medicine. ▪ It is founded on the concept of four humours as a therapeutic method: phlegm, blood, yellow bile, and black bile.Built on the idea of "Mizaj," or temperament, which refers to individual variances. ▪ Collection of mental and physical traits that are indicated by specific physical and mental symptoms.	▪ Earth, Air, Fire, and Water are the four elements. ▪ Four temperaments (body and personality types) are: melancholic, sanguine, phlegmatic and choleric. ▪ Four qualities are hot, old, wet and dry.
VII. Islamic Traditional Medicine (Arabic) [60,61]		▪ Originated in 7th century. ▪ Often referred to as "Medicine of Prophet" ▪ Amplifying existent theoretical medical ideas into a comprehensive system of medicine	▪ Medicinal plants ▪ Dietary practises ▪ Mind-body treatment ▪ Applied therapy ▪ spiritual healing
VIII. American Traditional	Native America	▪ Thousand years ago. ▪ Native diets, and the usage	▪ Cupping ▪ Leeching

	Medicine [62]		of local flora for healing have all been utilized. ▪ Enhance health through associating with the environment. ▪ Ceremonial gatherings also play a role in healing process.	
IX.	Tibetian Traditional Medicine [63]	Tibet	▪ Centuries old traditional medicinal system. ▪ Also referred to as Sowa-Rigpa medicine. ▪ Uses a complex method of diagnosis. ▪ To treat sickness, uses behavioural and food change, natural medications and tangible treatments. (For example, Tibetan acupuncture, moxabustion, and so forth.)	Four tantras: ▪ root ▪ exegetical ▪ instructional ▪ subsequent
X.	Indian Traditional Medicine [64]	India	▪ Traced back to Indus Valley Civilization. (Rig-Veda era) ▪ The medicinal plants is used for treatments and cosmetic ingredients. ▪ A big part of contemporary medical knowledge has developed via trial and error across many cultures and areas.	▪ Ayurvedha ▪ Yoga&Naturopathy ▪ Unani ▪ Siddha ▪ Homeopathy

Table 1.2: Traditional Diagnostic methods/Tools

Diagnostic methods/Tools	Vatham	Pitham	Kapham
Naa (Tongue)	Black color	Yellow or red color	Pale color
Mozhi (Speech)	Standard-pitched tone	Sharp-pitched tone	Deep-pitched tone
Niram (Color)	Dark color	Yellow or red color	Pale color
Kan or Vizhi (Eye or sight)	Muddy conjunctive	Yellow or red color	Pale color
Sparism (Touch)	Dry	Warm	Chill
Malam (Stool)	Black color	Yellow or red color	Pale color
Siruneer (Urine)	Pattern of a snake	Ring shape pattern	Pearl shape pattern
Naadi (Pulse)	Vatham (degree of distortion)	Pitham (degree of distortion)	Kapham (degree of distortion)

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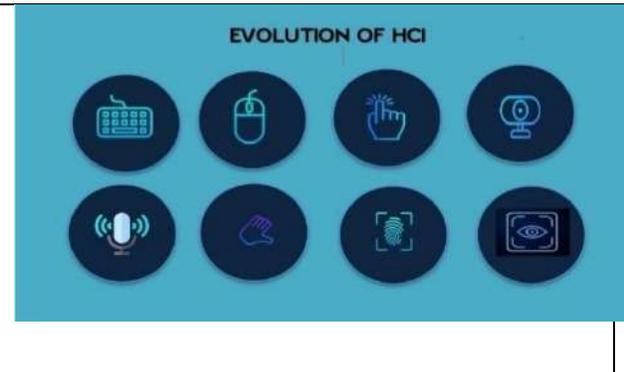
Fig 1.1 Evolution of HCI – User Interfaces
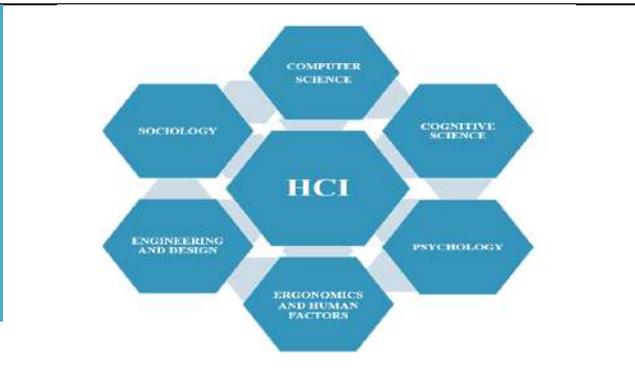
Figure 1.2: Multidisciplinary HCI

Fig: 1.3 Image sources from google images

Fig 1.4 Types of Indian Traditional Medicine.
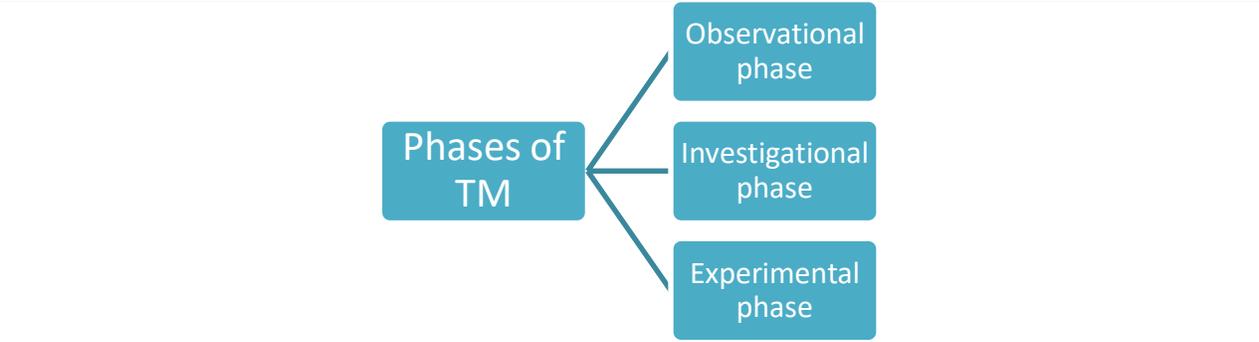
Fig 1.5 Phases of Traditional Medicine

RESEARCH ARTICLE

Case Study of Hitide Sea Farms (Prawn Farming) in Sirkazhi Taluk of Nagapattinam District – An Economic Analysis

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ABSTRACT

India's large coastline enables significant exploitation of marine resource. Because of the high profit margins on prawns owing to their high export value. Between 1991 and 1994, brackish water prawn aquaculture expanded, particularly around the coast. The formation of the Aquaculture Authority of India in compliance with Supreme Court orders for granting licenses and general control has regulated shrimp cultivation. Because of their international appeal, unique taste, high unit value, and expanding global demand, shrimp are regarded as the "Pinkish Gold" of the sea. Following the Green and White Revolutions in India, the Blue Revolution is currently underway to capitalize on the immense potential in the fisheries industry. Overfishing of shrimp from natural sources, along with a rising demand for shrimp products on the worldwide market, has resulted in a significant gap between demand and supply shrimp in the international market. As a consequence, new avenues for increasing Prawn productivity must be explored. The estimated brackish water area suitable for shrimp aquaculture in India is around 11.91 lakh hectares. The 1.2 lakh hectares are scattered throughout 10 states and union territories and include West Bengal, Orissa, AP, Tamil Nadu, Pondicherry, Kerala, Karnataka, Goa, Maharashtra, and Gujarat. Right present, there are several opportunities for entrepreneurs to join the shrimp farming sector. In the research, the "Case Study of Hitide Sea Farms (Prawn Farming) in Sirkazhi Taluk of Nagapattinam District - An Economic Analysis" was assessed. The BCR value is more than one, suggesting that the unit is lucrative, according to the research. The financial study for the entire shrimp

farming system produces the following results: BCR - 1.28. Because shrimp have a strong export potential, it is advised that shrimp farms be built in the way indicated in this case study for bank financing consideration. Shrimp farming will be more lucrative in the future, according to the study.

Keywords: Prawn, Brackish Water, Shrimp Farming, Technical Feasibility, Income Statement, Benefit Cost Ratio and Financial Ratios.

INTRODUCTION

India has a long coastline, which allows for extensive exploitation of marine wealth. Because of the enormous profit margins on prawns due to their export value. During 1991-1994, brackish water prawn aquaculture boomed, particularly in coastal districts. The formation of the Aquaculture Authority of India in compliance with Supreme Court orders for granting licenses and general control has regulated shrimp cultivation. Because of their international appeal, unique taste, high unit value, and expanding global demand, shrimp are regarded as the "Pinkish Gold" of the sea. Following the Green and White Revolutions in India, the Blue Revolution is currently underway to capitalize on the immense potential in the fisheries industry.

Brackish Water shrimp farming Scope
Overfishing of prawns from freshwater sources, along with increased global demand for shrimp products, has resulted in a considerable disparity between demand and supply of prawns in the global marketplace. As a result, new routes for expanding Prawn output must be explored. In India, the estimated brackish water area suitable for shrimp agriculture is roughly 11.91 lakh ha. West Bengal, Orissa, AP, Tamil Nadu, Pondicherry, Kerala, Karnataka, Goa, Maharashtra, and Gujarat make up the 1.2 lakh ha spread across 10 states and union territories. There is a lot of opportunity for entrepreneurs to enter the shrimp farming industry right now.

Location of the Project
The first and most significant condition for commencing on any enterprise is the purchase of adequate land. The data of identified/surveyed land in coastal districts is available from the relevant state government's department of fisheries and the MPEDA Regional offices functioning in India's coastal states. An appropriate location is one that can provide optimal conditions for shrimp growth at the desired production level. The state government owns the majority of the land along the coast. In other circumstances, the entrepreneur must obtain a long-term lease from the state government's revenue agency. If it is private land, it should better be purchased outright. When choosing a location for the project, the entrepreneur should consider the following

1. Even during the rainy season, this region should be accessible, ideally by road.
2. No mangrove area with huge tree trunks is chosen.
3. There is a clean water supply on the site, which includes both freshwater and brackish water.
4. The water quality parameters required for optimum feed efficiency and development of Penaeus monodon are stated below (Table – 1).
5. The locations are not prone to flooding.
6. Choose a location with a natural slope for good drainage.
7. Social issues arising from conflicting uses of water resources and waste water drainage must be addressed.
8. The availability of appropriate infrastructure, such as energy, an ice plant, cold storage, and communication facilities, among other things, is required for effective administration.

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Profile of the Firm
Details of the Entrepreneurs

        Name of the Entrepreneur : Mr. Suryakumar
        Age   : 53
        Educational Qualification : Master of Science (M. Sc)
 Mechanical Engineering,
  B.Tech (1970-1945).

Culture/ Fresh Water: Prawn culture.
History of the Firm:

        Name and Address of the Enterprises   : **HITIDE SEA FARMS [Prawn]**
                                                                        Mahendrapalli, [Kattur],
                                                                        Sirkazhi [TK], Nagapattinam [Dt].
        Year of Start   : 1989
        Nature of Business   : Producers
        Nature of organization   : Individual.

Technical Feasibility of the Project
Technical Requirements for Establishing a Large Shrimp Farm
Shrimp Farm Design and Construction
A large shrimp farm should cover between 0.4 and 0.5 hectares of land and, ideally, be drainable. Concrete dikes, raised concrete supply canals with separate drain gates, and sufficient equipment such as generators and aerators are common features of ponds. The water canals' design, height, and direction must be suited to the elevation of the region, with special care given to the mean range of tidal fluctuation. Canals and dikes may be built as close together as undulation allows saving money on construction.

General Earth Work
It is normally carried out in the following order;
1. Cleaning up the site.
2. Removal of top soil.
3. Marking out the center of templates and lines.
4. Dike foundation preparation.
5. Drainage canal excavation.
6. Dike development (peripheral and secondary).
7. Dike farming and deformation.
8. Pit excavation for fences.
9. Pond bottom equalization.
10. Gate construction and pit replenishing.
11. Dike protection works.
The top soil may be kept and reused to maintain the pond bottom fruitful.

Shrimp Farm's Essential Components
1. Ponds
2. Structure for water input.
3. A location for harvest cleaning.
4. A pump house and a workshop.
5. A watch and ward room, as well as an office and a small laboratory.

Ponds

Ponds of 0.4ha to 0.5ha size are preferable from a management standpoint. These ponds can be entirely drained. Primary and secondary dykes separate the ponds. A perimeter dike may also be built to provide total protection to the cultured stock and any connected infrastructure. The height of the perimeter dike will be determined by the following factors:

1. Water level in the level
2. Elevation above mean sea level
3. Free board height
4. The percentage allowed for soil shrinkage

Each grows out pond's size and limits are regulated by the partition dykes, and its height is governed by the following elements:

1. The height of the water column in the pond
2. Free board
3. Wave action
4. Shrinkage factors

The shrinkage factor is determined by the kind of soil, which might be heavy, medium, or light.

Gates

They are in charge of managing the pond's input and outflow of water, as well as maintaining the proper water column in the pond. The main gates are built on dykes and separate ponds. It might be made of concrete, PVC, or asbestos-containing pipe.

Drain Canals

They have a trapezoid, and the area of their and the velocity of the water's flow define their discharge capacity.

Pond Preparation

Pond preparation will result in increased output. The primary goals of pond preparation are:

1. To eliminate weed fishes and creatures.
2. To eliminate unpleasant gases.
3. To eliminate the pond ecosystem's inherent production.
4. Maintaining excellent water quality for healthy development and survival.
5. Unwanted species are often eradicated by emptying the whole pond and drying the pond bottom until it cracks.
6. It also aids in the elimination of poisonous gases and oxygenation of the pond bottom.

It also increases the fertility of the soil. Liming is a procedure used to balance pH and destroy dangerous bacteria and viruses. To get rid of weed fish in non-drainable ponds, use   200 ppm Mahua oil. Organic and inorganic fertilizers are utilized to replace the soil and water after about two weeks. The water level increases as the thick lab-lab is created, and the pond is ready for stocking.

Selective Stocking

The Indian white prawn Penaeus indicus and the Tiger Prawn Penaeus monodon are the best species to rise in India. Traditional shrimp farming is permitted inside the CRZ, with production ranging from 1 to 1.5 tons per acre each crop and stocking density ranging from 40000 to 60000 tons per acre per crop, depending on the kind of system employed and the species. Outside the CRZ, extensive shrimp farming with an output range of 100,000/ha/crop may be authorized. It is often necessary to utilize hatchery seeds to guarantee that the cultured animal develops evenly.

Food and Feeding

Shrimp diets may be either supplemental or comprehensive. In a large system, shrimp need a diversity of feed. Natural foods have high conversion values, but they are difficult to manufacture and store in big quantities. The bulk

of aquaculture farms now depend on necessary feed at a 1:1.5-1.8 ratio. Feeding may be accomplished via the use of automatic feed dispensers or manually dispersing feed throughout the pond. Feeding waste may be reduced by placing feeding trays in certain locations of the pond.

Harvesting
Emptying the pond and manually plucking with a bag net allows for complete harvesting. The usual culture period is 120-150 days, during which time the Prawns develop to be 20-30 grams in size (depending on the species). Two crops may be harvested in the same year. Before shipping shrimp to market, place them between layers of crushed ice.

RESULT AND DISCUSSION

Physical and Financial Outlay
The physical and financial outlays for establishing a 1ha brackish water prawn farm are detailed below. The overall cost of growing the first harvest for a 1ha Prawn farm, including working capital charges, comes to Rs. 27 lakhs. Invoices for different purchases will be attached. (Table - 2).

Benefit Cost Ratio
Fixed Cost

    1. Land Lease Amount   = Rs. 1,00,000
    2. Value of Aerator   = Rs. 2,00,000
        Total   **= Rs. 3,00,000**

Variable Cost

    1. Pond Preparation (1ha) = Rs.30,000
    2. Value of Seed   = Rs. 2,00,000
    3. Value of Feed   = Rs. 10,40,000
    4. Value of Labour   = Rs. 1,50,000
    5. Value of Fertilizer   = Rs. 40,000
    6. Value of Electricity   = Rs. 4,50,000
    7. Miscellaneous   = Rs. 40,000
        Total   **= Rs. 19,50,000**

Interest on Working

Capital @ 12%   = 12/100 * 19,50,000
        = Rs. 2,34,000

Total Variable Cost= 19,50,000+2,34,000
        = Rs. 21,84,000

Total Cost of Cultivation (TCC)   = Fixed Cost + Variable Cost
        = 3,00,000 + 21,84,000
        = Rs. 24,84,000

Cost of Production /Kg   = Total Cost / Qty. of Production
        = 2484000/30000 = 248.4

Prawn Sales (10000kg* Rs. 320)   = Rs. 32,00,000
Gross Income   = Rs. 32,00,000
Net Income   = Gross Income / TCC
        = 32,00,000 / 24,84,000
        = Rs. 7,16,000

Benefit Cost Ratio (BCR)   = Gross Income / TCC
        = 32,00,000 / 24,84,000

BCR   **= 1.28**

Inference

Since, the BCR value is greater than one, so the unit runs profitably.

Income Statement
Receipts

Returns from the Prawn	= Rs. 32,00,000
Gross Cash Income	= Rs. 32,00,000
Gross Income	= Rs. 32,00,000

Expenses
Fixed Expenses

Land Lease Amount	= Rs. 1,00,000
Value of Aerator	= Rs. 2,00,000
Total Fixed Expenses	= Rs. 3,00,000

Operating Expenses

Pond Preparation	= Rs. 30,000
Seed Cost	= Rs. 2,00,000
Feed Cost	= Rs. 10,40,000
Other Inputs	= Rs.40,000
Labour Cost	= Rs.1,50,000
Electricity	= Rs.4,50,000
Miscellaneous	= Rs.40,000
Total	= Rs. 19,50,000

Interest on Operating

Expenses @12%	= 12/100 * 19,50,000
	= Rs. 2,34,000
Total Operating Expenses	= 19,50,000+2,34,000
	= Rs. 21,84,000
Net Cash Income	= Gross Cash Income - Total Operating Expenses
	= 32,00,000 - 21,84,000
	= Rs. 10,16,000
Net Operating Expenses	= Gross Income - Total Operating Expenses
	= 32,00,000 - 21,84,000
	= Rs. 10,16,000
Net Farm Income	= Net Operating Income - Fixed Expenses
	= 10,16,000 - 3,00,000
	= Rs. 7,16,000

Financial Ratios

1. Operating Ra = Total Operating Expenses / Gross Income
= 21,84,000 / 32,00,000
= 0.683
2. Fixed Ratio = Total Fixed Expenses / Gross Income
= 3,00,000 / 32,00,000
= 0.093

Total Expenses =Total Fixed Expenses + Total Operating Expenses
= 3,00,000 + 21,84,000
= Rs. 24,84,000
3. Gross Ratio/Input-Output Ratio   = Total Expenses / Gross Income

= 24,84,000 / 32,00,000
= 0.776

Financial Viability

The following assumptions have been established for undertaking shrimp culture inside and outside the CRZ were presented in table – 3, The financial analysis for extensive system of shrimp farming results is as under BCR-1.28.

Marketing

Because of the large difference between supply and demand for shrimps in both the domestic and foreign markets, selling the same may not be an issue. Farmers may sell shrimp directly to the market or to exporters for processing before shipping. Shrimps may be delivered frozen, with or without heads, battered and breaded, IQF, or in any other value-added form. The prawn must be packaged in accordance with importing countries' norms, which should be decided after a comprehensive market investigation. It is usually a good idea to contact local distribution agents in the customer's nation. The hygiene packing, presentation, and look of the package are important considerations in attracting importing country customers.

CONCLUSION

According to the study, the BCR value is more than one, indicating that the unit is profitable. The financial study for the whole shrimp farming system generates the following results: BCR - 1.28. Because shrimp have a high export potential, the building of shrimp farms in the manner described in this case study is suggested for bank funding consideration. According to the research, shrimp farming will be more profitable in the future.

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Table – 1 Water Quality Parameters

Water Parameter	Optimum Level
Dissolved oxygen	3.5-4ppm
Salinity	10 – 20ppm
Water temperature	26-32 c
PH	6.8-8.7
Total nitrate nitrogen	1.0ppm
Total ammonia(less than)	1.0ppm
Biological oxygen demand	10ppm

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Chemical oxygen demand	70ppm
Transparency	35cm
carbon dioxide	10ppm
Sulphide	0.003

Table – 2 Estimated Physical and Financial Outlay Involved for Setting Up   of A Shrimp Farm: Economic Analysis

S. No	Items	Unit	Price	Rupees
1.	Pond Preparation	1 ha		30,000
2.	Seed Cost	5.0 L	400/1000	2,00,000
3.	Food Cost(5180425) =10000kgs* 1.3(FCR)	13000	80/KG	10,40,000
4.	Labour (2*15000*5m)	2	15000/lab	1,50,000
5.	Other Inputs	Lumps	40,000	40,000
6.	Aeration HPHR / Kg	4.5	10/HP HR	4,50,000
7.	Miscellaneous	1.0ha	40,000	40,000
8.	Land Lease Amount			1,00,000
9.	Value of Aerator			2,00,000
10	Interest on Working Capital @12 %			2.34,000
	Total Cost of Production			**24,84,000**

Table – 3 Financial Viability of the Shrimp culture

S. No	Particulars	Improved Traditional With In (CRZ)	Extensive Outside [CRZ]
1.	Size of Farm	1ha	1ha
2.	Culture Period	4-4.5 months	4-4.5 months
3.	Density of Stocking (PL-20)	50,000/ha	1,00,000/ha
4.	Survival	70%	65%
5.	Production(Expected)	1.2 tons/ha	2.5tons/ha
6.	Price of Shrimp has Been Taken	Rs.320/kg	Rs.320/kg

RESEARCH ARTICLE

The Effects of Various Mordant Combinations on Dyeing Cotton Fabric with Natural Dyes Extracted from Marigold Flower, Blueberries, Beetroot, and Blue Butterfly Pea Flower: A Comprehensive Study

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ABSTRACT

The utilization of natural sources to extract dyes serves as a means to mitigate environmental issues. Natural dyes primarily consist of extracts derived from agricultural products or insects, which are combined with mordants to effectively dye natural fibres with excellent colour fastness. These dyes can be categorized into three main types based on their origin: vegetable (plant), animal, and mineral-based dyes. The demand for natural dyes is on the rise due to their eco-friendly nature, providing a viable alternative to petrochemical-derived dyes. Plant-based dyes, which make up a significant portion of natural dyes, are extracted from various sources such as roots, wood, bark, berries, lichen, leaves, flowers, nuts, and seeds. Other natural dye sources include insects, shellfish, and mineral compounds. Natural dyes find applications in colouring textiles, leather, basketry, food products, cosmetics, and more. Additionally, natural dyes contribute to the sustainable development of rural areas, as they are renewable resources that help stimulate economic growth. An important advantage of natural dyes is

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their lack of adverse effects on human health. Moreover, waste generated from the natural dye industry is biodegradable and can be utilized as natural fertilizer, further enhancing its eco-friendly characteristics.

Keywords: Natural Dye, Mordants, textiles, biodegradable, eco-friendly.

INTRODUCTION

The art of dyeing textiles has a rich history that spans thousands of years, and its evolution has been shaped by the discovery and utilization of various natural dye sources. In recent times, there has been a renewed interest in exploring sustainable and eco-friendly alternatives to synthetic dyes. Natural dyes derived from plant sources have gained significant attention due to their potential to provide vibrant colors while minimizing environmental impact. Furthermore, understanding the effects of mordant combinations on the dyeing process can enhance the colorfastness and durability of dyed fabrics. This comprehensive study aims to investigate the effects of different mordant combinations on the dyeing process of cotton fabric using natural dyes extracted from marigold flower, blueberries, beetroot, and blue butterfly pea flower. Mordants play a crucial role in the dyeing process by forming a complex with the dye molecules and facilitating their bonding to the textile fibers. They not only improve colorfastness but also influence the shade, intensity, and color variations obtained. Previous studies have explored the dyeing properties of individual natural dyes, but limited research has focused on investigating the effects of mordant combinations on multiple natural dyes. By examining various mordant combinations and their impact on different natural dyes, this study aims to provide a comprehensive understanding of the dyeing process and its outcomes. Recent advancements in dyeing technology, coupled with increasing environmental concerns, have emphasized the need for sustainable textile practices. By utilizing natural dyes and exploring optimal mordant combinations, textile industries can minimize their ecological footprint and offer consumers environmentally friendly options.[1] Furthermore, understanding the interplay between natural dyes and mordants can provide insights into the preservation and revival of traditional dyeing techniques. By harnessing the knowledge from traditional practices and combining it with scientific understanding, we can create a bridge between the past and the future, revitalizing age-old dyeing traditions while embracing modern sustainable approaches. In conclusion, this comprehensive study aims to contribute to the body of knowledge on natural dyeing by examining the effects of various mordant combinations on cotton fabric dyed with natural dyes derived from marigold flower, blueberries, beetroot, and blue butterfly pea flower. By elucidating the impact of mordant combinations on the dyeing process, this research has the potential to enhance the quality and sustainability of textile dyeing practices.[2]

MATERIALS

Cotton fabric: A fabric made from cotton fibers, which will serve as the substrate for dyeing experiments. Natural dyes: Extracts or pigments derived from marigold flowers, blueberries, beetroot, and blue butterfly pea flowers. These natural dyes will be used to impart color to the cotton fabric. Mordants: Substances used to enhance the affinity of the natural dyes for the cotton fabric and improve colorfastness. Different mordants, such as Aloe-Vera, Cream of tartar (C.T) Alum Eucalyptus Vinegar + C. TAlum + Vinegar + C. T, can be used in various combinations to explore their effects on the dyeing process and color outcomes. Stainless steel pots: Containers made of stainless steel, used for preparing dye baths and mordant solutions. Source of heat: A heat source, such as a Bunsen burner or hot plate, pH indicators, Stirring rods or utensils, Water, Measuring equipment, Labels and markers, Safety equipment:

METHODS
Step 1- Extraction Method
A] Extraction of dye from Marigold Flower (Tageteserecta L.)

To extract dye from marigold flowers, follow these steps: Collected fresh marigold petals and separate them from the flowers. Take the separated marigold petals and boil them in a pot containing three times the amount of water as compared to the petals. Allow the petals to boil in the water until the solution reaches the desired color. This process helps to extract the dye from the petals. As the boiling progresses, the volume of the solution will reduce. Continue boiling until the extract becomes approximately one-fourth (¼) of the initial amount of water used. Once the desired color is achieved and the extract has reduced to the desired volume, remove the pot from the heat source. Filter the extract to separate it from any residue or solid particles. This can be done using a fine mesh strainer, cheesecloth, or a coffee filter. Carefully pour the extract through the filter, allowing it to pass through while retaining any solid materials. Discard the residue that remains in the filter, as it contains the plant material that has been separated from the dye extract.[3]

Extraction of Dye from Blueberries & Beetroot

First, collect a batch of vibrant, blue-colored wild blueberries and place them in a pot. Ensure they are clean and free from any impurities. Next, wash the blueberries thoroughly to remove any dirt or debris. Once the blueberries are cleaned, gently crush them using a blender or a similar crushing device. This step helps to break down the berries and release their natural dye content. After crushing the blueberries, carefully filter the mixture to separate the liquid dye from the solid residue. The residue, consisting of the leftover berry pulp and skin, can be discarded, as we are only interested in the dye extract. The extracted dye is now ready to be used for various purposes, such as dyeing fabrics or creating artistic projects that require a beautiful blue hue. Similarly, the extraction process can be applied to beetroot to obtain its natural red dye. Wash the beetroot thoroughly, peel if necessary, and then crush it to release the dye. Filter the mixture to collect the vibrant red dye, which can be utilized for dyeing or other creative endeavors.[4]

C] Extraction of Dye from Blue butterfly pea flower(Clitoriaternatea)

To extract dye from Blue Butterfly Pea flowers (Clitoriaternatea), collect and chop the flowers into small pieces. In a pot, combine the chopped flowers with water at three times the flower volume and add 1 teaspoon of salt per cup of water. Boil the mixture until the desired color is achieved. Once boiled, allow it to cool slightly, then filter the extract to separate the liquid from the flower residues. Store the extracted dye in a glass jar or bottle in the refrigerator for later use as a natural coloring agent for fabrics.[5]

Mordanting

Mordanting is a crucial process in natural dyeing that enhances the color fastness and affinity of the dye to the fabric. It involves three stages:

Premordating

In this stage, the fabric, usually cotton cloth, is prepared by boiling it in a solution of alum and water, with a ratio of 5 grams of alum per liter of water, for about 10 to 15 minutes. This step helps the fabric to absorb and retain the dye more effectively.

During Extraction

Sometimes, mordants are added directly to the dye bath during the extraction of the dye from the source material (e.g., Blue Butterfly Pea flowers). Common mordants used at this stage include vinegar, alum, salt, among others. These mordants assist in binding the dye to the fabric and improve color intensity.[6]

Post Mordanting

Also known as washing, post-mordanting is the final stage of the mordanting and dye extraction process. After dyeing the fabric, it is thoroughly washed to remove any excess dye and mordants that have not been fixed to the fabric. This step helps to ensure that the colors remain vibrant and that the fabric is safe to use.

Drying

Remove the cotton cloth from the dye bath & leave it to dry at room temperature.

Washing & Post mordanting

The dried colored cotton cloth is then rinsed in a mordant solution of alum &water & leave to dry. After the fabric has been dyed using the extracted dye from Blue Butterfly Pea flowers (Clitoriaterna tea), the drying process is carried out as follows

Drying

Once the fabric has absorbed the dye and achieved the desired color, it is removed from the dye bath. The dyed cotton cloth is then taken out and left to dry naturally at room temperature. During this stage, the dye molecules further bond with the fabric fibers, resulting in better color fastness and fixation.

Washing & Post Mordanting

After the fabric has dried, it is essential to wash it to remove any excess dye that did not bind to the fibers during the dyeing process. The dried, colored cotton cloth is rinsed in a mordant solution containing alum and water. This post-mordanting step ensures that any remaining unbound dye is removed from the fabric and helps enhance the color's stability and permanence. After washing in the mordant solution, the fabric is once again dried, completing the dyeing process.[7]

RESULT AND DISCUSSION

Initially, the cotton cloth was subjected to dye extraction without any mordant, resulting in poor coloration, and the color quickly faded upon washing. To improve the dyeing process, the cotton cloth was pre-mordanted with alum before being dipped into the dye bath. The observations revealed significant improvements compared to the samples without any pre-mordanting. The cotton exhibited richer coloration than the untreated samples, and even after washing, it retained a relatively higher level of color intensity. Subsequently, the cotton cloth was pre-mordanted with alum and then immersed in a dye bath already treated with various mordants such as salts, vinegar, and alum. This combination produced even better results, with the cotton achieving a deeper and more vibrant color than the previous samples, and the color remained darker even after washing. These findings clearly demonstrate the positive impact of using mordants in the dyeing process. Furthermore, the effectiveness of different mordant strengths and application methods was evident, with stronger mordants and specific application techniques yielding superior outcomes compared to untreated samples. Thus, the strategic use of mordants plays a crucial role in achieving successful and long-lasting dyeing results on cotton fabrics.

CONCLUSION

In conclusion, the use of mordants significantly enhances the dyeing process of cotton cloth with Blue Butterfly Pea flower extract. When the cotton cloth was pre-mordanted with alum before dyeing, it showed a considerable improvement in coloration compared to samples without any mordant. Additionally, the post-mordanting process, where the fabric was immersed in a dye bath already containing mordants like salts, vinegar, and alum, resulted in even more vibrant and long-lasting colors. The strategic application of mordants demonstrated that stronger mordants and specific mordanting techniques yield better results. Overall, mordanting plays a crucial role in achieving superior dyeing outcomes, ensuring that the colors adhere well to the fabric and remain vivid, even after washing. By understanding and employing appropriate mordanting techniques, one can achieve high-quality and durable-colored textiles, showcasing the versatility and beauty of natural dyes.

CONFLICT OF INTEREST

All the authors declared that there is no any conflict of interest.

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Table No: 1Impact of mordants over method of treatments

Sr. No	Mordants / Method of treatment	Premordated Unwashed	Wash with Detergent and water	Soak in alum and salt and wash with detergent (Post Mordating)
1.	Aloe-Vera			
2.	Cream of tartar (C.T)			
3.	Alum			

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4.	Eucalyptus			
5.	Vinegar + C. T			
6.	Alum + Vinegar + C. T			

Figure no: 1 Solubility test for marigold dye

Figure no: 2 Results After Dye bath and Washing

RESEARCH ARTICLE

Multispectral Image Feature Extraction based on Normalized Object Indexing Model with Deep Learning Techniques

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ABSTRACT

Rich spectrum information can be extracted from targets using multispectral imaging, substantially enhancing the capabilities of conventional imaging technologies. In the fields of agriculture, the military, medicine, industry, and meteorology, multispectral imaging is frequently utilized. Multispectral images have redundant information, thus pre-processing is required to decrease the dimension. Most researchers now use pre-processing techniques before classifying data in recent years. This study suggested a unique deep learning model-based method for extracting multispectral picture features. Here, noise removal and smoothing pre-process the raw multispectral image. The retrieved features from the processed images are then classified using the arbitrary object indexing model (ANGCBF_AOI), Adapted Normalized Graph cut Boundary Fuzzy Classifier, and Q-reinforcement with kernel component (QRKC). Multispectral data have grown in size as a result of the increased need for information about objects and advances in sensor resolution. For the multispectral picture collection, experimental analysis is done in terms of accuracy, precision, recall, and F-1 score.

Keywords: multispectral image, feature extraction, deep learning model, kernel component, arbitrary object indexing.

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INTRODUCTION

The development of sensor technology has allowed multispectral sensors to currently record earth's surface reflectance in hundreds of frequency bands. Multispectral images can therefore be utilized for a variety of tasks, such as environmental monitoring as well as categorization. According to the Hughes phenomenon, for instance, classification accuracy decreases as dimensionality increases and the number of training samples is constrained. Strong correlations between [1] neighbouring and nonadjacent bands in multispectral images are possible, which reduces the amount of data is utilized for further analysis, such as categorization. The extraction of certain properties is necessary for accurate categorization. This work introduces the novel unsupervised feature extraction method known as Band Correlation Clustering (BCC). Proposed technique consists of three main steps: calculating bands' correlation coefficient; clustering bands using correlation coefficient matrix; calculating means of every cluster using a novel feature extraction method. Real-time multispectral image classification is aided by having a large set of picture classifications, which is only achievable using a "machine learning approach"[3].

Convolutional Neural Networks (CNN) have received accolades for being the best in class in a relatively short period of time due to its exceptional performance in terms of accuracy as well as dependability[4]. In comparison to traditional learning procedures, deep learning profound multiple levelled depictions necessitates an incredibly larger arrangement of the image collection. Regardless of the fields, multispectral pictures are being used in many different applications. The image-based Authentication System (AS) is one of the programmes that is commonly utilized. These days, there is a lot of concern about image uprightness validation because advanced photographs can be successfully altered and the adjustment is difficult to spot. Currently, a growing number of tactics are being researched to handle the problems with image correction. Because sophisticated images can be easily altered and because the RGB (Red, Green, and Blue) adjustments might vary, image-based identification and verification systems are becoming more and more popular. Iris and fingerprint pictures are used in biometric authentication systems to verify users [5]. SVM approach is evaluated in terms of classification accuracy and processing speed. The generated features are fed into two supervised classifications—the nonparametric Support Vector Machine (SVM) and parametric Machine Learning (ML)—for evaluation procedure. Use of unsupervised feature extraction by clustering yields comparable outcomes. An analysis of the data shows that suggested BCC performs well in terms of computing costs to improve classification step accuracy [6].

Related works

Several ML techniques, like as RF, SVM, ANN, decision trees, and Max Ent, are widely applied in wildfire science [7]. Furthermore, burned sites were identified utilizing dense harmonic time-series of Land sat data[8]. Additionally, RF as well as seed-growing method based on time-series Landsat-8 photos and GEE were used to map all burned areas worldwide [9]. For burned-area mapping in Mediterranean region using one post-fire Landsat-5 TM image, author [10] examined a number of ML methods, including ANN, SVM, and Ada Boost Classifier (Ada Boost), and discovered that all methods demonstrated comparable accuracy. Variance imposed by approaches is less than variance imposed by regionally distinct factors in research sites, according to work [11] that examined 10 categorization methods. Additionally, study [12] employed LR to determine with tolerably high accuracy the probabilities of burned scars from a single post-fire Land sat 7 ETM+ image. In the Mediterranean region, author [13] suggested a (semi)-automated multi criteria technique for burned area mapping using uni-temporal Landsat TM photos. In spite of its ability to minimize commission errors by roughly 21%, this soft aggregation method could only reduce omission errors by less than 3%. According to work [14], informative channels were recalibrated with greater weights employing FC layers and channel-wise attention to recalibrate various feature channels. Convolutional layers were used by the author [15] to suggest a spatial attention mechanism, and the learnt attention map can be used to identify informative regions in every feature map. In [17], a simplified version of [16] was put out, in which FC layers as well as dilated convolutional layers, created channel and spatial attention maps. In [18], they suggested creating a symmetric network employing spatial un pooling as well as de convolution layers to enhance the FCN

model. This improved efficiency when categorising things in the image at different resolutions, but it still created a coarse label map. The categorization limits were refined by authors using a conditional random field (CRF) in post-processing stage. The main drawback of this de convolution network was that it took longer to train and used more memory than [19]. Using the Res Net DCNN, the Deep Lab semantic segmentation network was created.

Deep Lab uses arous convolutions in place of traditional convolution layers to reduce the effects of down sampling and improve the definition of segmentation boundaries. Although effective size of an convolution filter rises, number of trainable parameters stays constant since the space in between the sample points is filled with zeros. SVM was utilized in [20] to produce binary pictures, and linked component labelling, parametric contour tracing, and piecewise linear polygonal approximation were all employed to evaluate lake shapes for change detection analysis. A moderate-resolution image spectrora diometer (MODIS) dataset was used to extract and track lake surface dynamics when the SVM classifier was introduced in [21]. The Adaptive Boosting (Ada Boost) technique was suggested in Work [22] as a means of extracting the surface water bodies. Findings demonstrate that Ada Boost outperforms RF and DT both qualitatively as well as quantitatively. In [23], a Random under sampling boosting technique was put forth as well as used to extract the river network from Cyclone Global Navigation Satellite System (CYGNSS) data. With inclusion of further under sampling in every iteration, it is comparable to the Ada Boost method. The integrated pixel as well as object-based ML architecture was put forth by author [24] for the extraction and identification of water bodies.

System model
This section discuss novel technique for multispectral image feature extraction and optimization is estimated using Q-reinforcement with kernel component (QRKC) with Adapted Normalized Graph cut Boundary Fuzzy Classifier and the arbitrary object indexing model (ANGCBF_AOI). Feature is extracted in terms of SIFT, GLCM, geometric, and other features that are optimized with the BFMOA (boundary fuzzy model based in object arbitrary indexing) model. Proposed architecture is shown in figure-1. To increase quality for a more efficient process of picture enhancement as well as analysis, data is first level-0 preprocessed. To increase the size of this dataset as well as lessen classification issues around edges, training images were randomly cropped into patch tiles of 256 256 pixels. There are 197 validation patches and 1837 training patches altogether. As seen in Table 3, data augmentation was used to improve data set as well as prevent over fitting. On the input images, we performed rotation, area crop, aspect, colour jitter, step-scaling resize between 0.7 and 1.2 with step 0.1, flip operation with probability 0.5, mirror operation with probability 0.5, and additional operations. In order to standardize these augmented images between 0 and 1, the mean was subtracted, and the scale was set to unit variance.

Q-reinforcement with kernel component (QRKC)
In RL, the agent constantly engages with the world and gains knowledge through "trial and error," or the rewards provided by the environment. The agent "exploits" and "explores" during the learning process, adjusting the evaluation value of each action based on feedback from the environment, discovering the best course of action that would ultimately yield the most amount of word. The primary distinction between RL and supervised learning is that, as opposed to being given the right response, the agent in RL receives a reward signal from environmental feedback that signals the effectiveness of the action. This model's distinguishing feature is that the relationship between the reward and the subsequent state only applies to current state and action, not to previous state and action. A Markov decision process can be used to model a classification problem. The state s can be viewed as a sample, and the action to ascertain the class to which the sample belongs can be viewed as the state a. The environment will present a sample to the agent at each phase, and the agent will then decide on an action. Then, as illustrated in formula (1), the environment feeds back the reward to the agent based on the action the agent chose:

$$r_{t+1} + \gamma^* \max Q_t(s_{t+1}, a_{t+1}) \tag{1}$$

where the t-th sample's label, t l, is. Finding the best technique to earn more rewards is the agent's aim. Fig. 1 depicts the overall flow of the Markov decision process for the categorization problem.

State S Representative state space. The training samples determine how the environment is in its current state. The agent receives the first sample X1 as its initial state 1 s at the start of training, and state j s at time j corresponds to the j-th sample X j.

Action A Action is connected to the sample's label. The agent's chosen course of action is to forecast a class label. P stands for the likelihood that the existing condition will change once an action is taken. The transition probability p in this study is deterministic. Order of data set determines the agent's subsequent condition.

Policy π The chance of performing different actions at state t s is represented by the probability distribution function.

Reward R The instantaneous reward provided by the environment, which can gauge whether an agent's activities were successful or unsuccessful. Agents choose the appropriate policy based on the potential payoff.

Return G The cumulative reward, where is the discount factor, reflects a long-term advantage. To maximize profits is the goal of RL.

Q-learning function

The predicted reward of the agent executing the action t at the state t s is represented by the Q function in Q-learning by eqn (2)

$$Q_{t+1}(s_t, a_t) = Q_t(s_t, a_t) + \alpha^*\big(r_{t+1} + \gamma^*\max Q_t(s_{t+1}, a_{t+1}) - Q_t(s_t, a_t)\big) \tag{2}$$

The Bellman equation allows for the following expression of the Q function by eqn (3)

$$Q_{t+1}(s_t, a_t) = \alpha^*\big(r_{t+1} + \gamma^*\max Q_t(s_{t+1}, a_{t+1}) - Q_t(s_t, a_t)\big) \tag{3}$$

By resolving the ideal Q function, we can arrive at the ideal tactic π*. The greedy strategy can be used to find the best strategy if the best Q function is known. The following updates to the strategy are made by eqn (4)

$$\pi(a, s) = \{1 \text{ if } a = \arg\max Q(s, a) \tag{4}$$

To obtain the Q-learning formula's most recent version by eqn (5):

$$Q_{t+1}(s_t, a_t) = Q_t(s_t, a_t) + \alpha^*\big(r_{t+1} + \gamma^*\max Q_t(s_{t+1}, a_{t+1}) - Q_t(s_t, a_t)\big) \tag{5}$$

where γ is learning rate, and $r_{t+1} + \gamma^*\max Q_t(s_{t+1}, a_{t+1}) - Q_t(s_t, a_t)$ is Temporal-Difference Learning(TD) error, $r_{t+1} + \gamma^*\max Q_t(s_{t+1}, a_{t+1})$ is target evaluate of Q value. The goal of the Q function's update is to have $Q_t(s_t, a_t)$ roughly match the target estimate of Q. First, even for simple real-world issues, keeping a precise table for Q-function is impractical due to magnitude of S. Second, because it partially derives from a linear optimization, transition from one state to next is too complex to be represented by a model. To get around these issues, we use a NN Q that is parametrized by and optimized using a specific gradient method, similar to DQN (Deep Q Network) method, to approximate Q-function. The policy produced by Q-network is defined as πθ(s) = arg min a∈A Q̂(s, a; θ). In that scenario, standard Temporal Difference loss applied to train the Q-Network can be expressed using the straightforward formula by eqn (6).

$$L(\theta) = \mathbb{E}_{s, a \sim \rho(-)}\Big[\big(Q^{\pi_\theta}(s, a) - \hat{Q}(s, a; \theta)\big)^2\Big]_X \tag{6}$$

where the agent's behaviour distribution is. It should be noted that in eqn (3), parameter naturally affects observed Q-values through policy μ. Such a loss is quite intuitive: if L(θ) = 0 and Qπθ is consistent with Q(), then any B&B tree constructed by agent Q()is optimal with respect to Q() with probability 1.

Kernel component network

An 8-layer neural network is the proposed Kernel component. Figure 3 depicts the network architecture, and the following describes how each layer operates:

First layer (input layer) Although this layer doesn't perform any operations, it is in charge of pre-processing the input game graphics, which entails enlarging the images to 80 × 80 and timing the convolution procedure.

Second and third layers Convolutional layers make up both of these levels. The second layer has eight convolutional layers, and the third layer has four. Convolution kernels are 5 × 5 with a 1 step in size. Parameters of convolution kernels on both layers are obtained utilizing PCA evaluations, in contrast to parameters of convolution kernels in conventional CNN that are acquired from methods. First, images were gathered through game play as well as methods of random actions served as training examples before the convolution kernel parameters were calculated. There were n training samples in all, as shown by X = x1, x2, x3,..., xn. After then, additional samples are taken in the same manner to create the training set $X = \{\overline{x_1}, \overline{x_2}, \overline{x_3}, \dots, \overline{x_n}\}$ by eqn (7).

$$(k_h \times k_w) \times \left(\left(\frac{h-k_h}{s}+1\right) \times \left(\left(\frac{w-k_w}{s}+1\right)\right)\right) \tag{7}$$

Calculating xe1's covariance matrix is the next step. First, mean m of eX is determined with a size of 1×5776. Next, the new $\overline{x_n}$ is created by subtracting m from the original $\overline{x_n}$, and last, the new $\overline{x_n}$ is multiplied by its own transport. The same procedure is carried out on further training samples, and $\overline{x_n}$ is then calculated using the formulas in eqn (8). Covariance matrix is 25 × 25 in size.

$$\sigma = \frac{\sum_{i=1}^{n} \overline{x_i}\overline{x_i}^T}{\left(\left(\frac{h-k_h}{s}+1\right) \times \left(\left(\frac{w-k_w}{s}+1\right)\right)\right)} \tag{8}$$

Calculations of the aforementioned stages can also be used to derive the parameters of the four convolution kernels on third layer. However, a 2-layer convolution operation is performed on X = x1, x2, x3,..., xn to obtain XL2 = x11, x12,..., x18, x21, x22,..., x28.

Fourth layer Original input image will result in 32 feature maps (1 × 8 × 4) after second as well as third layers have undergone convolution operations. By superimposing the second and third layers, effects resembling those of multi-layer CNN are generated. But in order to produce a nonlinear change of the original activation function layer, we utilized block-wise histograms. The detailed operating procedure is displayed below. Feature map is utilized for binarization once third layer is convolved and is expressed as XL3, XL3 = x11, x12,..., x14, x21, x22,..., x24,...,..., x24,..., x84. The first step is to group the XL3 every four pieces, resulting in a total of n groups of feature maps, where n is number of convolution kernels on second layer. According to operation depicted in eqn (9), $\overline{x_n}, \overline{x_n}$ is 72 × 72. The next step is to divide xen into four blocks, each 18 by 18, denoted by $\widetilde{x_{1n}}, \widetilde{x_{2n}}, \widetilde{x_{3n}}, \widetilde{x_{4n}}$... The four blocks are combined into a 1024-dimensional vector and utilized for histogram statistics. Then, similar operations are performed on further collections of feature maps, and as this layer's output, all of them are combined into an 8192-dimensional eigenvector by eqn (9).

$$\widetilde{x_n} = \sum_{i=1}^{4} 1^{4-i} x_{ni}. \tag{9}$$

Fifth, sixth, and seventh layers Activities of fifth, sixth, and seventh layers, which are full connection layers with dimensions of 8192, 4096, and 512, respectively, are same as those of other typical, CNN.

Eighth layer Output layer is eighth and final layer. Output dimension, which in this paper was fixed at 2, is maximum number of actions that are managed by games.

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Adapted Normalized Graph cut Boundary fuzzy estimation

The segmentation utilizing adaptive normalized graph cuts based on divisions for inverse shape determination is part of the initial phase. Instead than concentrating on limited features and consistencies, adaptive normalized cut is a global measure for segmenting graph utilized in road picture data. This technique is employed as a criterion to assess total similarity and total dissimilarity between several sets of road photographs. The segmented road photos are classified in the second stage using a boundary fuzzy classifier to determine the boundary in reverse. In order to develop a classification algorithm with a large capacity for simplification, boundary fuzzy classifiers are utilized. In order to demonstrate the border fuzzy classifier's generalizability in road photos, a large number of computational experiments are conducted. Classification assurance measures how accurately a border fuzzy classifier classifies an input segmented road image. An input road image is sent to class with highest product of compatibility as well as certainty factor by the fuzzy conjecture procedure. The final stage involves the recognition of images and location determination using an arbitrary object indexing. The road photos constitute the object, and utilize ing arbitrary object indexing, the precise location is examined. The constant vector's indexing information is all contained in the index table by equation (10).

$$\bar{R}(f) = \sum_{p \in P} E_p(f_p) + \lambda \sum_{p,q \in N} W_{pq}(f_p, f_q) \tag{10}$$

Where N is region method, Ep(fp) is result of giving the tag $f_p \in T$ to p, $\overline{Wp}$, $q(fp, fq)$ is result of giving pair p and q the tags fP, ƒq∈T to identify shape after segmentation. If and only if pair wise interfaces probable Wp, q fulfils, Equation (11) employs adaptive normalized graph cuts.

$$Wp, q(0,0) + Wp, q(1,1) <= Wp, q(0,1) + Wp, q(1,0) \tag{11}$$

By figuring out the forms, the minimum R(f) can be calculated quickly with modified normalized graph cuts. Equation 1 is referred to as a statistical term. Statistics term presupposes that entity consequence for allocating pixel 'P' to "backdrop" and "item" respectively. Smooth term indicates the shape of the next quantity in Equation 1. The "boundary" characteristics of segmentation are included in the smooth term. Wp, q should be understood as the result of a break between p and q. Since fuzzy logic can grade truth values, its values will fall between 0 and 1. This approach can be used to derive fuzzy rules in the IF... THEN format.

Definition 1 Let X be a set with elements x. Now, it is given as, X = {x : x ∈ X}.
Definition 2 Assume X has a subset A. A is referred to as a fuzzy set if it functions according to a membership dependent on circumstances.

Rules Nothing but IF...THEN sentences constitute rules.
Fuzzy Rules Rules create qualitative judgements using a scale of truth values. They contain IF and THEN sections.
Rough sets that are fuzzy-oriented enclose linked data in uncertainty. The need for user-supplied data is not necessary, but fuzzy-rough set feature choosing aids in significantly reducing the separate or real-valued crying knowledge. This technique can be used to continuous data and is inherently useful for categorizing datasets by eqn (12). $\mu R_p X(x) = \inf_y \Psi(\mu R_p(x, y), \mu X(y))$ $\mu R_p X(x) = \sup_y \gamma(\mu R_p(x, y), \mu X(y))$

$$P: \mu R_p(x, y) = \gamma_a \in p\{\mu R_a(x, y)\} \tag{12}$$

Similarity of objects x and y on feature an is a subset of feature μRa. In a conventional rough set, the relation is used to define μRp(x, y) crisp positive region by eqn (13).

$$\mu R_p(x, y) = \gamma_a \in p\{\mu R_a(x, y)\}_{\gamma_P'(D)} \tag{13}$$

Fuzzy oriented rough degree on dependency of $\gamma_P'(D)$ to subset P is given as $\gamma_P'(D) = \frac{\sum_x \mu_{POS, P(D)}(x)}{|U|}$

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A fuzzy oriented rough reduced set R is subset of C and D∈ R such that for all $a \in R, \gamma'_R(D) = \gamma'_C(D)$ and $\gamma'_{R-\{a\}}(D) \neq \gamma'_R(D)$

Arbitrary Object Indexing

Consider the predictable groups of multispectral images on the image plane, α where I1, I2, and I3, β are the group's multispectral images, and J1, J2, and J3 are the group's image points. The angle created from the point and the picture as well as the ratio of length to discover location denoted by a1/a2 and b1/b2 are used to locate multispectral images. Both ratio and value of affect the apex impact α. A technique to locate objects using an indexing table and image groups is developed using the probabilistic apex effect. For various arbitrary criteria, performance of image group arbitrary indexing of road photos is evaluated. To isolate image plane, image point, and group, utilize image group mentioned above. After classification, the arbitrary object indexing system efficiently recognizes the multispectral images.

RESULTS AND DISCUSSION

The major estimations considering separating surveyed are analyzed in the principal subsection of this portion. The nuances of the used datasets are given in the resulting portion. Then, the settings of estimations to show up at the arranged preliminaries are moreover given in this part. Finally, the preliminary outcomes are presented and inspected. The primary measurements in view of apportioning assessed are talked about in the main subsection of this segment. The subtleties of the utilized datasets are given in the resulting segment. Then the settings of calculations to arrive at the detailed trials are likewise given in this part. At last, the exploratory outcomes are introduced and talked about. In this part, we present revelations of various tests to condemn show of proposed method. A PC with going with features was utilized to test proposed creamer method: With a 32-bit working framework, an Intel(R) Core(TM) i5-7500 central processor, 4 GB of Smash, Windows 7, NumPy, SciPy, Pandas, Keras, and Matplotlib systems, and the Python 2.7 programming language, Dataset description This data set comprises of 7 items obtained in apparent, close infrared and warm range. Each subject is caught in an alternate center position with the goal that the data set can be utilized for an improvement of auto-center calculations. An aggregate sum of pictures is 420. Photos gained in apparent range are separated into 7 sets, while each set contains 12. There are incorporated these articles: earphones, console, keys, amplifier, blender, shades and guitar. Pictures in data set of pictures in visual range were procured utilizing Nikon D80 camera with 50 mm f/1.8D AF Nikkor focal point. We moved physically centering ring in 5 mm steps. No extra lighting was needed thusly we didn't utilize streak light. Photos obtained in close infrared range are partitioned into 7 sets, while every set contains 21. There are incorporated these articles: building, vehicle, hall, head, console, office work area as well as pens. All pictures in data set of infrared pictures were caught with Group EOS 350D camera with Ordinance EF-S 18-55 mm, f/3.5-5.6 focal point. Camera was acclimated to catch EM radiation in NIR range by eliminating infrared channel before CMOS picture sensor. We mounted a B+W 093 infrared channel on focal point. This channel impedes all noticeable light as well as permits just infrared light over 850 nm to pass. We moved physically the centering ring in 1 mm steps in this analysis which brought about 21 pictures in every set. We utilized implicit glimmer to light indoor scenes. Open air scenes were shot without extra lighting. The above table-1 shows processing of various dataset based on segmentation and classification using proposed techniques. the input image of various dataset has been segmented and classified multispectral image is shown using proposed technique. Confusion matrix for proposed model based on both testing and training model of the input multispectral dataset is shown in figure 4 (a), (b).To process the last presentation of a bunching calculation as far as exactness, one can first relabel its result parceling so as to have maximal coordinating with the ground genuine names and afterward count the level of the genuine grouped examples. So the blunder rate not set in stone subsequent to tackling the correspondence issue between the marks of determined and known groups. The precision recall analysis of proposed model for training and testing is shown in figure 5 (a), (b).The misfortune is a summation of mistakes created by every cluster in preparing or approval sets, which demonstrates how appropriately or severely a prepared method performs after every cycle of enhancement.

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A weighted scanty soft max cross-entropy misfortune capability is utilized to follow presentation in preparation stage. It especially picks loads as indicated by the ongoing marks and applies them as group loads, and afterward joins the computation of soft max activity as well as cross-entropy misfortune capability to give an all the more mathematically stable inclination. It very well may be seen that the preparation misfortune steadily diminishes with an expansion in preparing steps. All organizations show combination towards zero with some negligible jitter somewhere in the range of 0.01 and 0.05. ROC analysis for proposed model for testing and training model is shown in figure 6 (a), (b) which has been analyzed for input dataset. Here, the outcomes were addressed by "1" and "0", "- 1", "1" implies that the order (mean) precision got by proposed model is fundamentally higher than those of different strategies. " 0" really intends that there is no massive contrast between them. " -1" implies that the exhibition of proposed model is fundamentally more awful than those of different strategies. Table-2 shows analysis based on testing and training data. Here parameter analyzed are accuracy, precision, recall, f-1 score. For test data proposed technique accuracy 95%, precision 91%, recall 99.5%, f-1 score 90.13%; while existing ANN attained accuracy 85%, precision 80%, recall 70%, f-1 score 69%, FNN accuracy 88%, precision 85%, recall 76%, f-1 score 73%. The proposed technique accuracy 95%, precision 90%, recall 99.5%, f-1 score 89.78%; while existing ANN accuracy 86%, precision 81%, recall 72%, f-1 score 70%, FNN accuracy 89%, precision 86%, recall 76%, f-1 score 75% for training dataset as shown in figure 7 (a), (b). These samples, which are ground truth labels that assess the suggested recognition system, are produced from the photo interpretation result.

 For training and classification purposes, the dataset is randomly split into two equal portions. The term Principal Feature (PF) can be used to denote those features contributing to the best answer, as goal of study is to determine combination of features that performs better during classification. The elements chose in every DL method can reflect various degrees of semantic data from low to high. Profound convolution layers during encoder branch progressively separate low-goal portrayals. Different amounts of semantic data, ranging from low to high, can be reflected in features chosen in every DL method. The encoder branch's deep convolution layers gradually extract high-level characteristics, such as contour features as well as hotspot distribution brought on by burned areas, from low-resolution representations (or representations at a low level). Decoder branch with up sampling subnet work plans to recuperate high-goal portrayals (i.e., exact division) like copied certainty, precise copied outline, and unburned regions around copied regions. Note that not every one of the highlights can be pictured well or seen naturally, so here we select main component in a few regular layers in element representation results, which are typical peculiarities in DL field.

CONCLUSION

This research propose novel technique in multispectral image feature extraction using deep learning model based on Adapted Normalized Graph cut Boundary estimation with Q-reinforcement with kernel component (QRKC)will be implemented for the feature extraction. Through the extracted features Objects are indexed means we need to assign the attributes to the variables we extracted in the images. Those indexed features are optimized for dimensionality reduction to increase the processing time. The division capacity of 25 elements was inspected and a blend of 9 highlights was viewed as extremely productive with generally speaking order precision of 84.4%. The outcomes are very reassuring on the grounds that the proposed highlight blend accomplishes higher order precision than standard consecutive choice techniques. It is worth focusing on that the order exactness rises when a piece of 25 elements is utilized. This finding adjusts to past perceptions that highlight determination can bring about exactness improvement. The preliminary discoveries show that the calculation acts in accordance with the prescribed procedures. Thus, a general model is made, and it very well may be utilized for an assortment of picture informational collections. In like manner, we will actually want to isolate the more unambiguous classes like volume all the more precisely. later on scope isolation of blended class gatherings, it has not yet been explored alongside profound learning method, and it very well may be considered for future exploration headings.

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Table-1 Proposed technique based various image analysis

Input image	Pre-processed image	Segmented image	Extracted image
Office desk			
Car			
Corridor			

Table 2: Analysis based on testing and training data

Dataset	Techniques	accuracy	Precision	Recall	f-1score
Test data	ANN	85	80	70	69
	FNN	88	85	76	73
	(QRKC_ ANGCBF_AOI [PROPOPSED]	95	91	99.5	90.13
Training data	ANN	86	81	72	70
	FNN	89	86	76	75
	(QRKC_ ANGCBF_AOI [PROPOPSED]	95	90	99.5	89.78

Algorithm for Fuzzy Rough set based boundary estimation
Input: C, set of all Antecredents; D, set of Consequents. Output: R. Reduced set

$$: R - I : \gamma'_{\text{iet}} = 0 : \gamma'_{\text{mw}} \neq 0$$

$$: \text{while } \gamma'_{\text{aw}} \neq \gamma_{\text{irem}} \text{ do}$$

$$\gamma'_{\text{mer}} - \gamma'_{\text{mov}}$$

for all

$$\gamma_{\text{ore}} - \gamma_{\text{mov}}$$

for all $x \in (C - R)$ do

if $\gamma_R|x|$ then

$$k + k\Delta|x|$$

$$\gamma'_{\text{ese}} = \gamma_2(D)$$

ChecicastriR, y', X, T)

end if

end for

$$R + T$$

and while

$$: \text{return } R$$
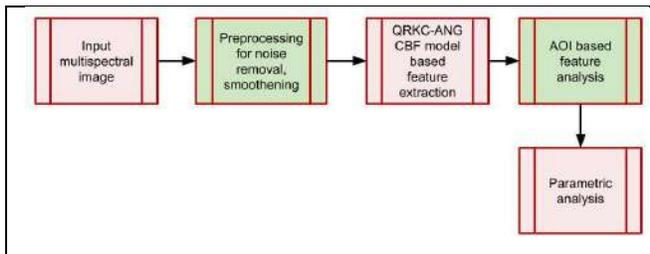
Figure 1: Proposed architecture
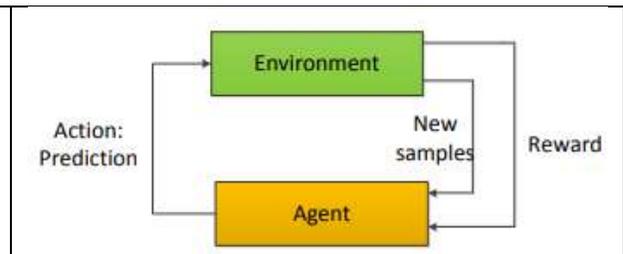
Figure. 2 Markov decision process in reinforcement learning
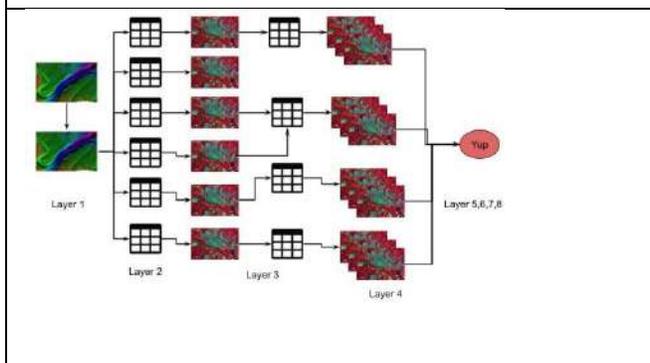
Figure. 3 Diagram of the proposed Kernel component network.
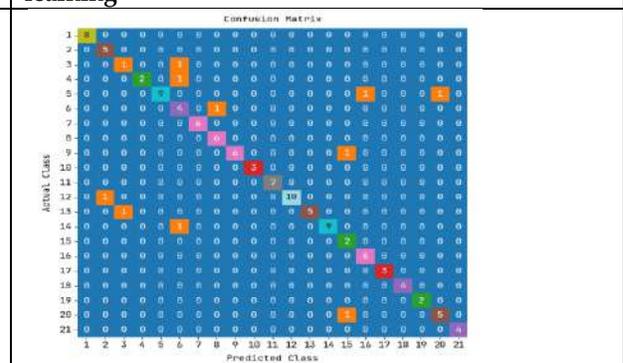
Figure. 4 (a) Test data analysis, Proposed model based confusion matrix for testing and training model of input dataset

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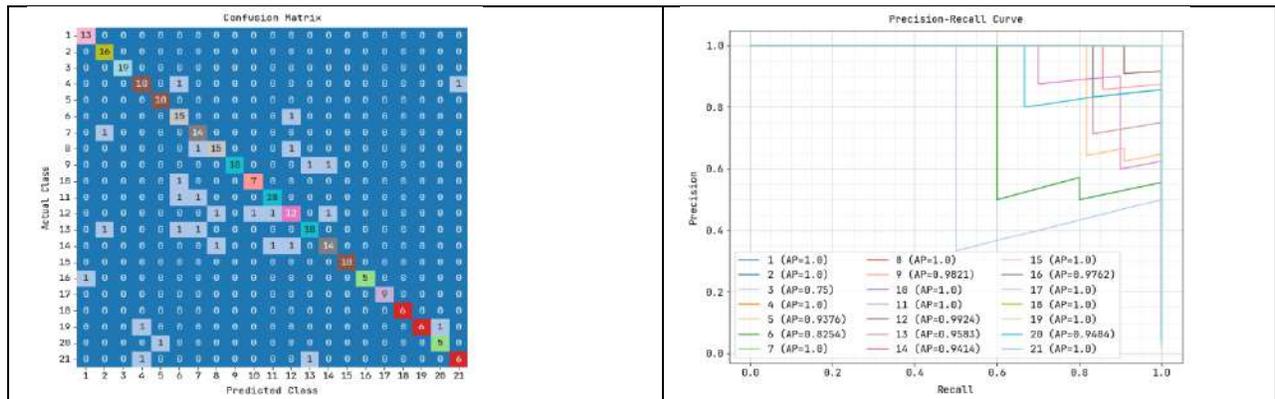
Figure. 4 (b) Training data analysis, Proposed model based confusion matrix for testing and training model of input dataset

Figure. 5(a) PR curve for test data, Proposed model based PR curve for testing and training model
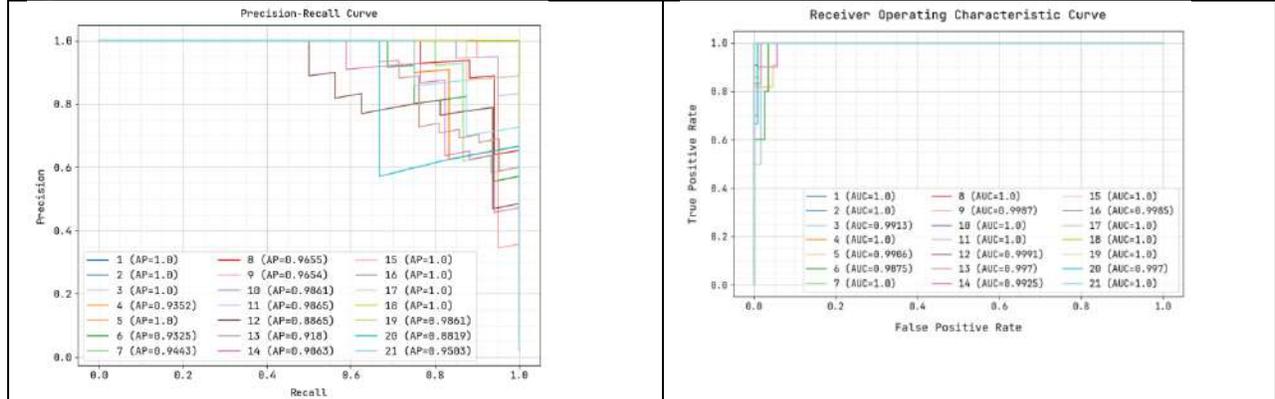
Figure. 5(b) PR curve for training data, Proposed model based PR curve for testing and training model

Figure.6 (a) ROC curve for test data, Proposed model based ROC curve for testing and training model
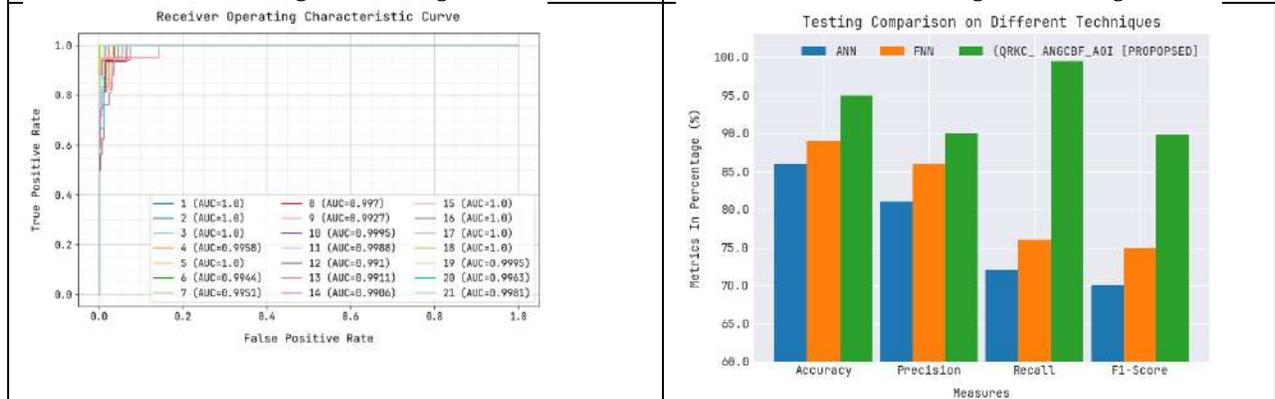
Figure6(b) ROC curve for training data, Proposed model based ROC curve for testing and training model

Figure. 7 (a) comparative analysis for test data, Comparative analysis

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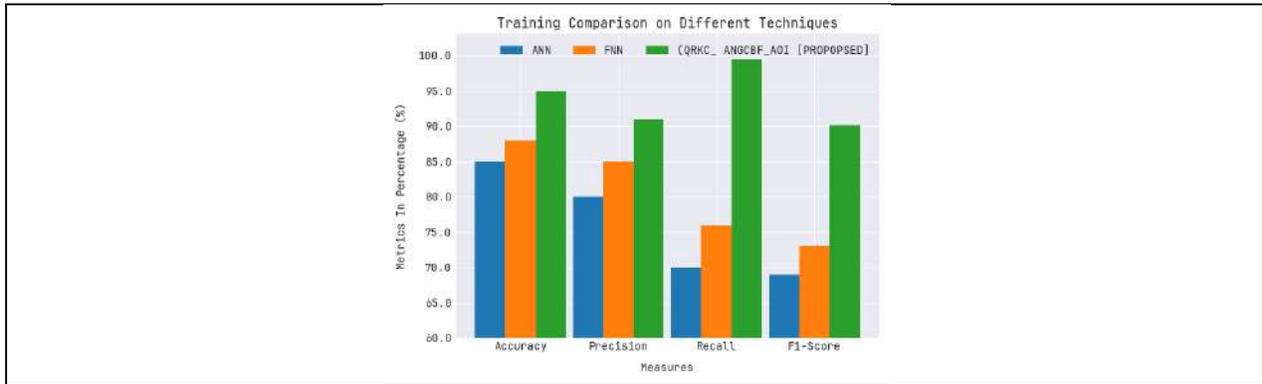
Figure. 7(b) comparative analysis for training data, Comparative analysis

RESEARCH ARTICLE

Prior Stage Kidney Disease Prediction with AI and Supervised Machine Learning Techniques

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ABSTRACT

Chronic kidney disease (CKD), also referred to as chronic renal disease, is a condition resulting from prolonged kidney damage persisting over months or years. Typically, the identification of this ailment involves screening individuals recognized to be susceptible to kidney issues. Early detection holds paramount importance in managing and treating the disease effectively. This research introduces machine learning methodologies, encompassing K-nearest neighbor (KNN), decision tree (DT), naive Bayes (NB), and support vector machine (SVM) algorithms, aiming to predict CKD in its early stages. The proposed approach seeks to enhance the timely recognition of kidney diseases, facilitating prompt intervention and elevating the quality of patient care.

Keywords: SB classifiers, Chronic kidney, NB, and KNN, DT.

INTRODUCTION

In the contemporary context of public health, chronic kidney disease (CKD) stands out as a significant threat. Routine laboratory tests play a crucial role in identifying CKD, and available treatments can not only prevent its onset but also slow down its progression, mitigate complications arising from reduced Glomerular Filtration Rate (GFR), reduce the risk of cardiovascular disease, and enhance both survival rates and overall quality of life. Factors such as inadequate water intake, smoking, poor dietary habits, insufficient sleep, and various other elements contribute to the development of CKD. In 2016, a staggering 753 million individuals worldwide were affected by this condition, with 417 million being female and 336 million male. Unfortunately, CKD is often diagnosed in its advanced stages, occasionally leading to renal failure. The prevailing diagnostic method relies on urine analysis, incorporating serum creatinine levels and employing diverse medical techniques such as ultra sonography and

screening. Screening processes target individuals with hypertension, a history of cardiovascular disease, existing illnesses, or a family history of renal disease. This diagnostic method involves assessing the albumin-to-creatinine ratio (ACR) in a first-morning urine sample and estimating GFR based on the serum creatinine level. To enhance prediction accuracy, this research focuses on leveraging machine learning techniques such as ACO and SVM, emphasizing feature reduction and selection for optimal results.

MATERIALS AND METHODS

Research methodology and techniques are described below for future proposed work.

LITERATURE REVIEW

[J. Snegha, 2020][10] suggested a research using back propagation neural networks and the Random Forest algorithm, among other data mining approaches. Here, they evaluate the two algorithms and discover that the BackPropagation technique produces the greatest results since it makes use of the Feed forward Neural Network, a supervised learning network [Mohammed Elhoseny, 2019] This paper proposed is designed for the selection of features related to chronic kidney disease (CKD), and it employs a combination of Density-based feature selection and Acute Component Optimization (ACO) techniques. Additionally, the system incorporates wrapper methods to facilitate feature selection. [Baisakhi Chakraborty, 2019][9] The proposal entails the development of a CKD prediction system using a range of machine learning methods, such as K-Nearest Neighbor, Logistic Regression, Decision Tree, Random Forest, Naïve Bayes, Support Vector Machine, and the Multi- Layer Perceptron Algorithm. These techniques will be applied and assessed based on accuracy, precision, and recall metrics. Following a comprehensive evaluation, the Random Forest algorithm is chosen as the optimal solution for implementing this CKD prediction system. [Arif-Ul-Islam, 2019] The proposed system involves disease prediction using Boosting Classifiers, Ant-Miner, and the J48 Decision Tree. The primary objective of this research is twofold: first, to assess the effectiveness of boosting algorithms in the detection of CKD, and second, to extract rules that elucidate the relationships among CKD attributes. The experimental findings demonstrate that Ada Boost performed slightly less effectively than LogitBoost in terms of performance. [Nilesh Borisagar, 2017] Outlined is a research work that employs the Back Propagation Neural Network algorithm for predictive purposes. This system explores the use of various algorithms, including Levenberg, Bayesian regularization, Scaled Conjugate, and resilient back propagation. For implementation, MATLAB R2013a is utilized. After considering training times, it is observed that both the scaled conjugate gradient and resilient back propagation algorithms exhibit greater efficiency compared to Levenberg and Bayesian regularization.

[S.Belina V, 2018] A proposed research work has been put forth, which combines the use of Extreme Learning Machine (ELM) and Ant Colony Optimization (ACO) for predicting Chronic Kidney Disease (CKD). The classification process is carried out using the MATLAB tool, with ELM featuring some specific constraints in the optimization process. This approach represents an enhancement within the context of Sigmoid additive types of Single Layer Feed forward Networks (SLFNs). [Siddheshwar Tekale, 2018][8] A research work has been detailed, employing machine learning techniques such as Decision Trees and Support Vector Machines (SVM). After a thorough comparison of these two methods, it was ultimately determined that SVM yields the most favorable outcomes. Furthermore, the prediction process is notably time-efficient, enabling doctors to promptly assess patients' conditions within a shorter timeframe. [Guneet Kaur, 2017][7] A research work has been suggested for the prediction of Chronic Kidney Disease (CKD) using Data Mining Algorithms within the Hadoop framework. This system leverages two data mining classifiers: K-Nearest Neighbor (KNN) and Support Vector Machine (SVM). In this system, predictive analysis relies on the manual selection of specific data columns. Notably, the SVM classifier demonstrates superior accuracy compared to KNN.[Neha Sharma, 2016] A research work has been put forward to analyze a patient's kidney disease and automatically compute results based on the patient's dataset. This system employs a rule-based prediction method and utilizes a neuro-fuzzy approach to derive outcomes through

mathematical calculations. [Kai-Cheng Hu, 2015][6] A research work has been suggested that employs an Ant Colony Optimization (ACO) approach for clustering, utilizing multiple pheromone tables. In this system, the problem is segmented into various patterns based on their distinct features. Two separate pheromone tables are utilized: one for tracking promising information and the other for storing unpromising details. This dual-table approach enhances the likelihood of exploring different search directions.

DATASET AND METHODS

Dataset

The dataset we utilize in this context is sourced from the publicly available CKD Dataset found in the UCI repository. This dataset comprises 400 samples, categorized into two distinct classes. Among its 25 attributes, 11 are numeric, 13 are nominal, and one serves as the class attribute. It's important to note that this dataset contains instances with missing values. The dataset's information is derived from patient data, including details such as age, blood pressure, specific gravity, albumin, sugar, red blood cells, and more. Chronic Kidney Disease (CKD) can be attributed to conditions like diabetes and hypertension. Diabetes has a significant impact on multiple organs, often leading to elevated blood sugar levels. Detecting the disease in its early stages is crucial. This study enhances several machine learning techniques to improve disease prediction. CKD is caused due to diabetes and high blood pressure. Due to Diabetes our many organs get affected and it will be followed by high blood sugar. So, it is important to predict the disease as early as possible. This study improvises some of the machine   learning techniques to predict the disease.

METHODS

Proposed System Architecture

After this all-procedure classification and scaling machine learning algorithms will be applied for acquire desirable results. Following testing, result analysis and comparison will be done for proposed research work. Same methodology will be applied for training dataset. As delineated in the previously presented system architecture, the chronic kidney disease (CKD) dataset undergoes a division into two components: the training set and the test set. Within the test dataset, the Synthetic Minority Over-sampling Technique (SMOTE) is utilized for sampling. This technique introduces additional diversity to the dataset, serving to mitigate the risk of over fitting and address potential challenges associated with biased decision boundaries that may arise in the presence of imbalanced data. Following the application of SMOTE, the Min-Max normalization technique is implemented—also recognized as feature scaling. In the realm of machine learning, Min-Max normalization transforms numerical values into a predefined range, typically spanning from 0 to 1, while preserving the original relationships among values. Following this, a comprehensive process involving the application of classification and scaling machine learning algorithms is executed to yield desirable outcomes. Upon the conclusion of the testing phase, an analysis of results and comparisons will be undertaken for the proposed research work. The same methodology is consistently applied to the training dataset to ensure uniformity and reliability in the assessment of outcomes.

Pre-Processing

Data Pre-Processing is that stage where the data that is distorted, or encoded is brought to such a state that the machine can easily analyze it. A dataset can be observed as a group of data objects. Data objects are labelled by a number of features, that ensures the basic features of an object, such as the mass of a physical object or the time at which an event ensured. In the dataset there may be missing values, they can either eliminated or estimated. The most common method of dealing with missing values is filling them in with mean, median or mode value of respective feature. As object values cannot be used for the analysis, we have to convert the numeric values with type as object to float64 type. Null values in the categorical attributes are changed with the most recurrent occurring value current in that attribute column. Label encoding is done to translate categorical attributes into numeric attribute by conveying each unique attribute value to an integer. This automatically changes the attributes

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to int type. The mean value is premeditated from each column and is used to replace all the missing values in that attribute column. For this function we are using a function called imputer which is used to find the mean value in each column. After the replacing and encoding is done, the data should be trained, validated and tested. Training the data is the part on which our algorithms are actually trained to build a model. Validation is the part of the dataset which is used to validate our various model fits or improve the model. Testing the data is used to test our model hypothesis. Various applied classifiers for proposed work is examined below.

KNN

In pattern recognition, the K-Nearest Neighbor algorithm (K- NN) is a non-parametric method used for classification and regression. In both cases, the input consists of the K closest training examples in the feature space. K-NN is a type of instance-based learning. In KNN Classification, the output is a class membership. Classification is done by a majority vote of neighbours. If K = 1, then the class is single nearest neighbor. In a common weighting scheme, individual neighbour is assigned to a weight of 1/d if d is the distance to the neighbour. The shortest distance between any two neighbours is always a straight line and the distance is known as Euclidean distance [7]. The limitation of the K-NN algorithm is it's sensitive to the local configuration of the data. The process of transforming the input data to a set of features is known as Feature extraction. In Feature space, extraction is taken place on raw data before applying K-NN algorithm. The steps involved in a K-NN algorithm. In summary, the K-NN algorithm involves the following steps:

1. Determining the K nearest neighbors based on the chosen distance metric.
2. Assigning class membership through a majority vote among these neighbors.
3. Potentially using a weighted scheme to account for neighbor distances.
4. Recognizing that K-NN's performance can be affected by local data configurations.

Optionally, performing feature extraction to enhance the input data representation before applying the algorithm.

NB

Naive Bayes is a classification method based upon Bayes Theorem which computes the likelihood for every attribute. It selects the outcome with highest probability. This classifier assumes the features are independent and that the existence of a specific feature in a class is not linked to the existence of any other feature. All the properties independently make a contribution to the probability, even if the features are dependent on other features. Naïve Bayes technique is mostly applicable for big datasets. It is elementary known to give exceptionally good results. Bayes theorem works on conditional probability. Conditional probability is the possibility of an occurrence to happen, given that some other event has already occurred. The equation to calculate conditional probability is given as

P(Hyp|Evi)=P(Evi|Hyp)*P(Hyp)/P(Evi)   *(1)*

Where, P (Hyp) is the possibility of hypothesis Hyp being true. P (Evi) is the possibility of the evidence (unrelated to the hypothesis). P (Evi|Hyp) is the possibility of the evidence when the hypothesis is true. P (Hyp|Evi) is the possibility of the hypothesis when the evidence is there.

DT

It is a predictive method to analyze the target value from a dataset on various given attributes. From the training data, it finds the attribute which segregate several instances. In order to achieve highest information gain, these instances are further classified. This procedure is applied over the smaller subsets in a repetitive manner until all the instances rightly placed in their class. In the given figure 1, the first level is a single header node which is a pointing node to its children. Attributes are denoted by internal nodes whereas the branches give possible values these attributes can have the terminal node depicts the final value of the target variable.

Classification

For the classification task, the Support Vector Classifier (SVC) is employed to predict the disease and evaluate its performance. The initial step involves importing the necessary libraries for classification and prediction, including SVC and datasets from the scikit-learn library, as well as Num Py for efficient mathematical computations. The accuracy score from the sk learn. metrics module is utilized to assess the model's predictive accuracy. The dataset is then divided into training and testing sets. Subsequently, the SVC is trained on the training data using the scikit-learn library, which encompasses built-in classes for various support vector classifier algorithms. In this case, the support vector classifier class, denoted as SVC in the scikit-learn's SVC library, is employed. This class requires a parameter specifying the kernel form. The fit method of the SVC class is invoked to train the algorithm on the provided training data, passed as a parameter to the fit method. To generate predictions, the predict method of the SVC class is utilized. For thee valuation of the algorithm, the confusion matrix is employed as a valuable metric.

SBC

Within the domain of machine learning, Support Vector Classifiers (SBC) represent supervised learning models equipped with associated learning algorithms designed for both classification and regression analyses. These algorithms scrutinize data to discern patterns and relationships. In the context of classification, the SBC training algorithm constructs a model based on a set of labelled training examples, each assigned to one of two categories. This model facilitates the assignment of new, unlabeled examples to specific categories, functioning as a non-probabilistic binary linear classifier. The essence of SBC lies in its capability to map data into a high-dimensional feature space. This transformation enables the classification of data points, even in situations where the original data might not be linearly separable. In essence, SBC leverages this high-dimensional representation to effectively categorize data points within a given space.

Min-Max normalization

Min-max normalization, also referred to as feature scaling or min-max scaling, is a data preprocessing technique employed to standardize and scale the range of independent variables or features within a dataset. This normalization approach alters the values of each feature to a predetermined range, commonly set between 0 and 1.

$$X \text{ normalized} = \frac{X - \min(X)}{\max(X) - \min(X)} \tag{2}$$

where: X normalized represents the normalized value of the feature. X signifies the original value of the feature. $\min(X)$ corresponds to the minimum value of the feature within the dataset. $\max(X)$ denotes the maximum value of the feature within the dataset.

Min-max normalization is commonly applied in various fields to standardize and scale the features of a dataset. Here are some common applications

Machine Learning

Feature Scaling: Min-max normalization is frequently employed in machine learning algorithms, particularly those involving distance calculations or optimization, such as k-nearest neighbors (KNN) and gradient descent. By scaling features, it ensures that no single feature dominates the learning process.

Neural Networks

Input Scaling: In neural networks, normalizing input features to a consistent range (e.g., between 0 and 1) contributes to faster convergence during training. This normalization helps mitigate issues such as vanishing or exploding gradients.

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Image Processing
Pixel Intensity Scaling: Within image processing, normalizing pixel intensities to a specific range is common practice. This normalization ensures uniformity in image data, making it compatible with various algorithms, especially those utilized in computer vision tasks.

Data Visualization
Color Mapping: Min-max normalization plays a crucial role in mapping numerical data to colors in data visualizations. This approach enables a clear representation of data distribution and trends.

Financial Modelling
Risk Assessment: In financial modelling, where features represent financial indicators with varying scales, min-max normalization facilitates the comparison and analysis of these indicators on a standardized scale. This, in turn, aids in risk assessment and decision-making.

Healthcare
Biomedical Data: Normalizing biomedical data, such as patient measurements, ensures consistent analysis and comparison of health-related features. This normalization is instrumental in identifying patterns and trends within patient data.

Economics
Economic Indicators: Economic indicators often come with different units and scales. Min-max normalization is valuable for comparing and analyzing these indicators, providing a standardized foundation for economic analysis.

Recommendation Systems
User Ratings: In recommendation systems, where user ratings for different items may be on disparate scales, normalizing these ratings ensures fair and consistent comparisons when generating recommendations.

Proposed Algorithm
Step 1: Start
Step 2: Take Input from Dataset.
Step 3: Data-preprocessing from Dataset.
Step 4: Divide Training and Testing data from Dataset.
Step 5: Outlier detection.
Step 6: Use SMOT Technique on Dataset.
Step 7: MIN-MAX normalization on Dataset.
Step 8: Train Model using NB, KNN, DT, SBC(Supreme Boosting Classifier) algorithm.
Step 9: Test Model.
Step 10: Output Comparison
Step 11: Result.
Step 12: End Result

RESULTS AND DISCUSSION

The following metrics offer insights into the quality of the results obtained in this study. To assess the performance of the classifier, we rely on a confusion matrix, which provides a detailed description of its performance.

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Precision

Precision, or positive predictive value, is calculated as the proportion of patients correctly identified as having CKD (true positives) to the total number of patients predicted to have CKD (including both true positives and false positives).

Precision =   TP
          TP + FP   *(3)*

Recall This metric, often referred to as sensitivity, represents the ratio of correctly identified CKD patients to the total number of patients who actually have CKD.

Recall = TP
    TP + FN   *(4)*

F- Measure This metric assesses the accuracy of a test and is calculated as the harmonic mean between precision and recall.

F-Measure= 2* Re call * Precision
              Re call + Precision   *(5)*

Accuracy It is the ratio of correctly predicted output cases to all the cases present in the data set.
Support is the correct number of outcomes or responses that are present in each class of the predicted outcome. Here, SBC classification report for future proposed work is given below which describes precision, recall, F1-score and support. Here is a table comparing different chronic kidney disease (CKD) predictions using Support Vector Classifier (SBC) of our proposed work.

CONCLUSION

This proposed work focuses on predicting Chronic Kidney Disease (CKD) in individuals by employing a wrapper method. Within this methodology, a meta-heuristic algorithm known as SBC is utilized. From the pool of 24 attributes, the top 12 attributes are selected as the most influential for making predictions. Machine learning techniques, specifically SBC, are applied to conduct the classification task. SBC is responsible for categorizing the outputs into two classes: one with CKD and the other without CKD. The primary goal of this study was to achieve accurate predictions for CKD patients while using a reduced number of attributes. The results indicate an impressive accuracy rate of approximately 99%.

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Table.1 List of attributes present in the CKD dataset.

Sr. no	CKD dataset		
	Attributes	**Type**	**Description**
1	Age	Numeric	Age of patient (in form of years)
2	Blood Pressure	Numeric	Blood pressure of patient (in mm/hg)

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Sr. no	CKD dataset		
	Attributes	**Type**	**Description**
3	Specific Gravity	Numeric	Patient urine of specific gravity
4	Albumin	Numeric	Patient Albumin (range 0-5)
5	Sugar	Numeric	Patient Sugar (range 0-5)
6	Red Blood Cells	Numeric	Patient red blood cells (value- normal and abnormal)
7	Pus Cell	Numeric	Patient Puc cell (value- normal and abnormal)
8	Pus Cell clumps	Numeric	Patient Puc cell clumps (values – present or not present)
9	Bacteria	Numeric	Patient bacteria (value- present or not present)
10	Blood Glucose Random	Numeric	Patient blood glucose random (value- mg/dl)
11	Blood Urea	Numeric	Patient blood urea (value- mg/dl)
12	Serum Creatinine	Numeric	Patient serum creatinine
13	Sodium	Numeric	Patient sodium
14	Potassium	Numeric	Patient potassium
15	Hemoglobin	Numeric	Patient hemoglobin (Molecule of protein within red blood cells)
16	Packed Cell Volume	Numeric	Patient packed cell volume (value in %)
17	Red Blood Cell count	Numeric	Patient red blood cell count (millions of cells per microliter)
18	White Blood Cell Count	Numeric	Patient white blood cell (millions of cells per microliter)
19	Hypertension	Nominal	Patient hypertension (values- yes or no)
20	Diabetes Mellitus	Nominal	Patient diabetes mellitus (values- yes or no)
21	Coronary Artery Disease	Nominal	Patient coronary artery disease (values- yes or no)
22	Appetite	Nominal	Patient appetite (values- good or poor)
23	Pedal Edema	Nominal	Patient Pedal Edema (value will be yes or no)
24	Anemia	Nominal	Patient Anemia (value - be yes or no)
25	Class	Class	Target variable (CKD or Not)

Table 2. Confusion Matrix.

Confusion matrix	CKD (Predicted)	Not CKD(Predicted)
CKD (Actual)	TP	FN
Not CKD (Actual)	FP	TN

Table. 3 Comparison table of CKD prediction using SBC.

Algorithm	Accuracy
KNN	94%
Naïve Bayes	96%
Decision Tree	97%
Supreme Boosting classifier	99%

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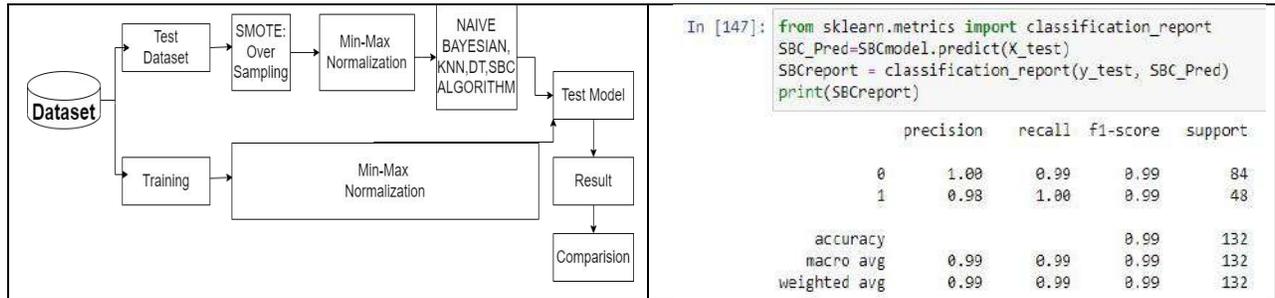
Fig. 1. Proposed System Architecture.

Fig. 2. SBC Classification report.
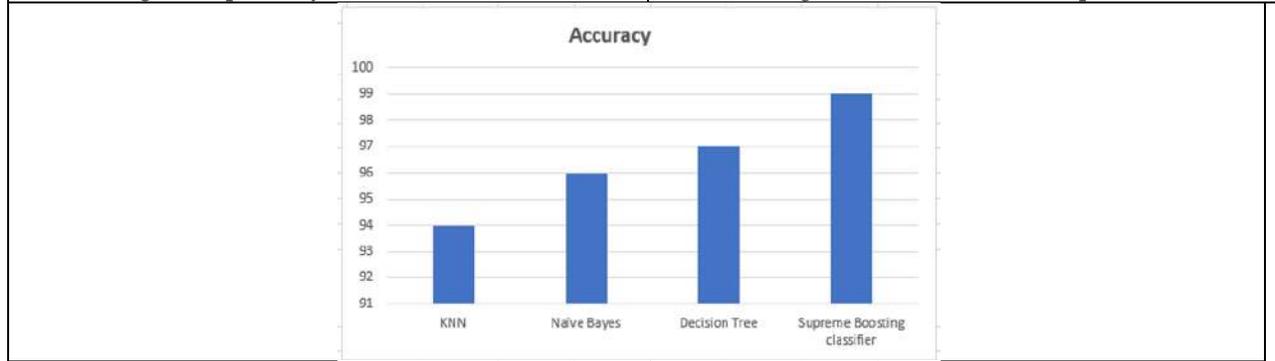
Fig. 3. Chart Results of CKD prediction using SBC.

RESEARCH ARTICLE

Optimization in Packing and Handling of Cartons with Help of Automation

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ABSTRACT

In basic terms, optimization is defined as a process that helps businesses improve their efficiency, increase their productivity and enhance their performance. Therefore, every organization strives towards achieving consistent improvement in productivity of their manufacturing processes which will in turn provide better quality to their customers. Optimizing several areas in industry, which results into increase in productivity such as improvement in facilities for manufacturing, reduction in men and material movement, improvement in material handling, change in layout to carry out operations without any disturbance or delay, improvement ecgonomics and safety of workers. This project addressed to setup a facility for packaging of milk powder carton packaging in dairy industry and its handling without manual interruptions to the storage by utilizing the various Automation techniques which will allow them to achieve a desired use of resources in economical way.

Keywords: Packaging, Plant layout, Automation, Conveyor system, Labour Cost, Productivity, material Handling.

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INTRODUCTION

It's great to see appreciation for the importance of automation in manufacturing and its rising demand. Automation has indeed played a significant role in the industrial revolution and continues to be a fundamental need in modern manufacturing. Automation is the use of technology to perform tasks with minimum human input. This includes enterprise applications such as business process automation (BPA), IT automation, network automation, automating integration between systems, industrial automation such as robotics, and consumer applications such as home automation. With decades of rising demand, this industry has been leading among the other dairy industries in Asia. The companies look after improving their productivity through finding the solutions to the problems faced during production to end customer for each product. Therefore, companies desire to produce the most output by effectively utilizing the available resources; and Amul dairy is one of them. The problem which affects the productivity of powder plant in Amul is manual taping of cartons and palletizing system for its transfer to storage. The company had material handling problem, excessive men and material movement in plant. Therefore, the objective was to implement automation in plant with help of multi-conveyor system to reduce the transfer time and eliminate manual packaging on the floor. A variety of milk powder is packed in a pouch. Strips of pouches are being packed of the different size and varying in weight in carton. It is packed with the taping machine and transferred to cold storage. Pallet stackers are being utilized to transfer packed cartons.

LITERATURE REVIEW

According to Abhilasha Dongre (2015) In this research paper, one can understand significance and importance of material handling also various aspects of material handling design have been considered like material form and its flow as well as demand. Nonetheless Availability of handling equipment is also the major factor. Therefore, the paper has suggested the proper selection of handling equipment for a particular task which influences the company's profit. According to Abhijit Gaikwad, Yogesh Raut ,Jitendra Desale , AkshayPalhe , Govinda Shelar in their paper named Design and Development of Automated Conveyor System for Material Handling shows actual model for the conveyor belt was made seeing its affecting parameter and calculation of speed, dimension and capacity considering the manufacturing industry where products are transported from one place to another. Mr. Ganesh G Shet ,Ms. Ganashree K G ,Mr. Abhishek A K ,Ms. Bhargavi authored paper illustrates the implementation conveyor system in packing and material handling. Also, it represents the need of automation in material handling for reduction of time and increment in Productivity of handling of boxes. Furthermore, it gives a future scope of implementation of this kind of FTP (File Transfer Protocol) system in the dairy industry. Prof. S. B. Mandlik , Patole Abhishek , Alase Aishwarya , Modhe Anuja authored research paper indicates the information regarding different components of Arduino based automatic packaging machines and also explains the usage of them in the industries for reducing time and increasing production speed.

PROBLEM IDENTIFICATION

The arrangement of filled milk powder pouches in cartons is done manually by workers in Amul diary's Anand Plant. After this Carton flaps are manually folded and inserted to the taping machine. This leads to inconsistency, more efforts and human errors. In order to provide a solution to this problem our project aims to fold the carton flap and taping of the carton to be done automatically. Also, the set up for transfer of cartons through conveyors. With this solution we aim to provide a reliable arrangement of complete carton packing and then transferring it by a conveyor system to minimize labor force and chances of error. The main issue where the organization is facing is buffer stock of cartons to be packed. Also, excessive men power and carton stacked on pallets lead to increase in chaos on the floor in some cases. Therefore, packaging and handling facility needs to be set up in a manner which eliminates buffer stock in both the stages and would be performed accurately in the same premises of the organization.

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Ineffective Arrangements

The current arrangement is not feasible for achieving higher productivity because the packing and storage is situated at long distance. The cartons are transferred from the powder packing department to the cold storage through a pallet stacker vehicle. The distance between is around 325m. This increases the lead time of the product.

Men and Material Movement

The movement of manpower increases due to the transporting of the material from one plant to another department. This creates fatigue and exhaustion to the manpower. The plant area suffers from a lack of organized material arrangement and an inefficient flow of materials. This leads to improper material movement, including instances of backtracking. Consequently, a great distance is traveled by materials, resulting in increased travel time and related delays.

Material Handling

The cartons and pallets are handled only with the help of a manual pallet stacker but, the movement of the stacked cartons only with a stacker is time consuming. Also, there are chances for collapse of carton stack in between distance. They needed to be repeatedly transported to storage location, but they are currently organized in a disorganized fashion. As a result, this process requires significant manual labor and consumes excessive time.

Manual Process

Currently, within the production line powder pouch arrangement, flap folding and palletizing like the majority of procedures are carried out using manual methods. There is an absence of partial or complete automation integration. Consequently, there is an increased expenditure of effort and time in executing tasks and accomplishing them. Moreover, the manual operations necessitate a workforce with specific skills.

Data Analysis in Existing Layout

The capacity of the plant is 75 MT/day.
1.   Average production / h is 3.347 MT/HR
2.   Average production / day is 73.148 MT/DAY
3.   Total production / month is 2121.290 MT/MONTH

Existing Layout

In Existing Layout, powder plant of Amul comprises 7 powder packaging machines with 10 filling heads.The carrying of cartons filled with various pouch sizes is highly in demand. There is a group of 48 work persons in a section per shift doing various activity from arranging pouches into carton, weighing and taping also the loading of cartons on existing butter conveyor line else palletizing cartons onto the pallet and with the help of manual pallet stacker it is carried to storage conveyor where manually cartons on pallet are unloaded onto the conveyor to be stored in cold storage. The average frequency of cartons at the taping machine is around 475 cartons per hour. The average time for packing is 10 seconds per carton. We were working on the solution in order to decrease packaging time i.e., reduction of around 3-4 seconds and with a single taping machine and eliminating manual folding of carton flaps in packaging. Also, the cartons are manually transferred onto a pallet else butter line conveyor which takes 10 seconds. Our main aim is to prepare a mechanism-based set-up where cartons can be transferred to the main storage conveyor system without any human involvement. The motive behind choosing this problem is simple which is overall cost saving and reduction in lead time. Nearly 48 workers work in a single shift in same plant hence the working conditions inside layout has scope for improvement. This provides an opportunity where a system could be incorporated which could reduce labor and help to increase effectiveness of packaging units.

Part Analysis

Analysis of problem resulted in the list of parts which are required for solution of the existing problem.

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DESIGN CALCULATION
Slope calculation for slider
Angle of slope at slider = A
Height of an angle = 45 Cm
Length of an angle = 25 Cm
Slope length = L1
Now by applying trigonometry rule
Tan(A) = 45 / 25
          = 1.8 rad
          = 60.94° ~ 61°
Sin(A) = 45 / L1
L1 = 45 / Sin(A)
   = 45 / Sin (61°)
   = 45 / 0.87
   = 51.45 Cm ~ 52 Cm
Slope calculation of conveyor line:
Height of an angle = 210 Cm
Angle of slope = 36°
Length of an angle = L2
Slope length = L3
Now again applying trigonometry rule
Sin(36°) = 210 / L3
L3 = 210 / Sin (36°)
   = 210 / 0.59
   = 357 Cm
Cos (36°) = L2 / L3
L2 = 357 x Cos(36°)
   = 357 x 0.8
= 288.82 ~ 289 Cm
Total length between conveyor = 640 Cm
Length of Conveyor = 289 Cm
Length of horizontal conveyor at beginning = 101 Cm
Remaining length for giving after passage to the cartons=640–289–101=250 Cm
Velocity calculation :
Diameter of driving Pulley (D) = 6 Cm
Max. Motor RPM (N) =1500
Velocity (V) = πDN / 60
              = π x 6 x 1500 / 60
              = 471.24 Cm/s
              = 4.7 m/s
Belt tension calculation :
Motor Drive power = 3 HP = 2.2 KW
Ratio of tensions = 1.2
Max. Power =((T1 - T2) x V) / 1000
((T1 - T2) x 4.7) /1000 = 2.2
T1 - T2 = 2200 / 4.7
T1 - T2 = 468
T1 = 468 + T2………… 1.
Now tension ratio is 1.2

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T1 / T2 = 1.2
Putting value of eq 1
(468 + T2) = 1.2 T2
1.2 T2 - T2 = 468
0.2 T2 = 468
= 2808 N

Width of conveyor belt (W) :
Safe tension of belt [T] = 36 N/Cm width
Max tension = T1 = [T] x W
W = T1 / [T]
   = 2808 / 36
   = 78 Cm
Friction calculation :
Max. Mass of a carton =13.3 Kg
Max. no. of cartons on the conveyor at a time = 3
Weight = mass x acceleration
        = (3 x 13.3) x 9.81
        = 392 N
Normal force = W x cos(36°)
             = 392 x cos(36°)
             = 317.14 N
Coefficient of friction = tan(36°)
                        = 0.73
Friction = friction Coefficient x normal force
        = 0.73 x 317.14
        = 230.42 N
Required Power calculation :
Belt pull = weight x friction Coefficient
          = 392 x 0.73
          = 286.16 N
Required velocity = 4 .7 m/s
Required Power = belt pull x required velocity
              = 286.16 x 4.7
              = 1345 watts
              = 1.35 KW
Efficiency of system
• Work done = normal force x slop length
            = 317.14 x (357 / 100)
            = 1132.19 Nm
            = 1.13 KW
• Efficiency = work done / required power
            = 1.13 / 1.35
            = 0.837
            = 83.7 %

CONCLUSION

After implementing this set-up, there will be reduction in manual interruption and increasing overall productivity of the material handling system with total automation by continuous conveyor line. Moreover, it will save the company's fiscal resources and hygiene of the plant as it is an essential criterion in any food industry. Also, the Project work will alleviate the damages of cartons and accidental situations in the plant caused by manual interruption. Overall, this setup will give back more benefits with slight investment.

FUTURE SCOPES
1. There can be a possibility to update the design by means of modern automatic technologies for better efficiency.
2. The sensor based handling and monitoring system can be used.
3. By using proximity sensors there will be chances to make the whole conveyor line automatically operated by means of separating and handling cartons automatically.
4. Driving mechanisms may have become fully automatic by using automatic monitoring and handling systems.

ACKNOWLEDGEMENT

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Table 1. Parametric Data of Cartons Amulya dairy whitener cartons Table 2 . Amul spray infant milk powder cartons

Sr. No	Packing Weight (gm.)	Pieces/ Carton (Nos.)	Gross Carton Weight (kg)	Carton Dimensions (inch)		
				Length	Width	Height
1.	11	840 Nos.	11.5 kg.	24.1	15.6	10
2.	22	480 Nos.	12.6 kg.	24.1	15.6	10
3.	500	24 Nos.	13.1 kg.	20.75	17.75	8.25
4.	1000	12 Nos.	13.2 kg.	19.6	13.6	8.6

Sr. No	Packing Weight (gm)	Pieces/ Carton (Nos.)	Gross Carton Weight (Kg.)	Carton Dimensions (inch)		
				Length	Width	Height
1.	11	840	11.5	24.1	15.6	10
2.	13.5	480	12.2	24.1	15.6	10
3.	22	480	12.6	24.1	15.6	10
4.	44	240	12.6	19.6	13.6	8.6
5.	200	60	13.2	16.75	13	13
6.	500	24	13.1	20.75	13.75	8.25
7.	1000	12	13.3	19.6	13.6	8.6
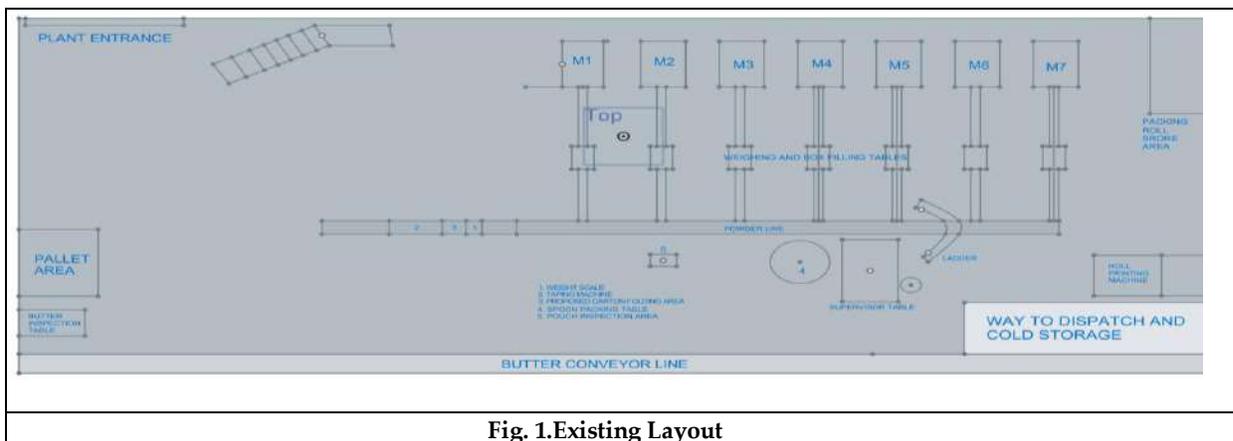
Fig. 1.Existing Layout

Fig. 2: Flap Folding Image (Not Actual Image*)

Fig. 3: Pallet Staking (Not Actual Image*)

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Fig. 4: Conveyor belt with stoppers	Fig. 5: Motor drive with Pulleys
Fig. 6: Rollers	**Fig. 7: Slider / Frame and support**
Fig. 8: Folding mechanism	**Fig. 9: Proposed Layout**
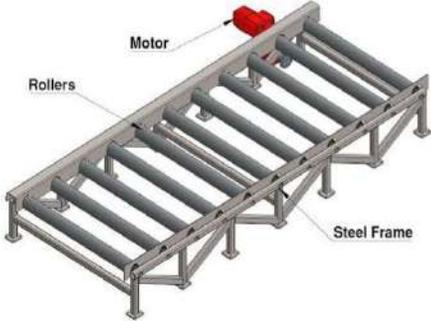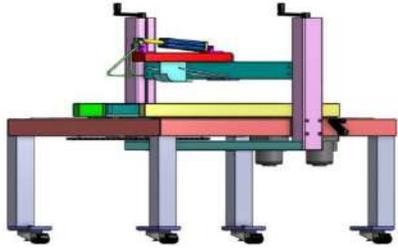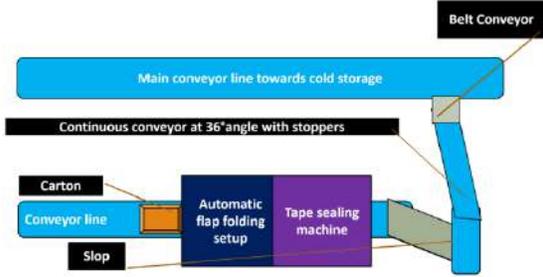
RESEARCH ARTICLE

Experimental Study on Pile Behaviour of Various Material and Soil Conditions under Uplift Load

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ABSTRACT

Due to wind, seismic events, wave action, or ship collisions, the foundations of various buildings, such as tall chimneys, transmission towers, mooring systems for ocean surface or submerged platforms, jetty structures, etc., are prone to overturning moments and uplift loads. Therefore, it is crucial to understand the pile's ability to carry uplift loads as well as the soil's propensity for failure under various soil conditions. Around the world, much study is being done to determine the uplift load bearing capability of cylindrical and belled piles made of various materials. The aim of conducting laboratory test is to get idea about behavior of different material of piles under pull out test as well as in different soil conditions. Furthermore, soil tests were also performed to get the soil parameters which are been used to for calculations. Soil test, namely Box shears test, Standard Proctor test and sand cone test. Pile materials which are used in this test are Concrete and Steel Pile.

Keywords: Pile foundation, Pull-out test, Displacement, Soil Conditions, Concrete Pile, Steel Pile

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INTRODUCTION

For foundation solutions for structures needing uplift resistance, such as high-rise buildings and transmission lines, uplift piles are frequently employed. Geotechnical engineering is still concerned on determining the location of the failure surface and assessing the ultimate uplift capability. There is little literature on the examination of the ultimate uplift capability and failure mechanism, and the pile-soil interaction mechanism is poorly known. While the calculation of the settlement induced by the superstructure should not exceed the limits of the allowable deformation for stability, function, and features of construction, the ultimate load bearing capacity attempts to determine the load that the pile can manage before failing. There are two methods that may be used to do research on the ultimate load bearing capability issues: A review of the relevant literature reveals that there are many soil types on which pile uplift load bearing capacity is examined. Many of the current design techniques for enhanced base pile uplift capability are based on the findings of modest laboratory model tests on anchor foundations. Since it was anticipated that soil parameters would not change for the uplift load study, analytical solutions, such as Meyerhof and Adam's technique of calculating uplift capacity theory in [6], were compatible with the experimental findings. [3] However, most of these theories cannot be used when the soil parameters vary with depth, and the analytical solutions that account for the non-homogeneity of the soils are approximations, which leads to erroneous findings.

LITERATURE REVIEW

Nazir et. al,[8] identify the capacity of an expanded base pier to resist uplift as well as the elements that influence its performance. The reinforced bin box with an extended base pier with a shaft diameter of 30 to 50 mm, base diameters of 75 to 150 mm, and base angles of = 30°, = 45°, and = 60° was used for the experiments. Both loose and thick sand packing were used for testing. For both loose and dense sand packing, a failure mechanism was investigated in a glass container. The net uplift capacity and failure displacement would be reduced by dry sand at the bell angle and shaft diameter. This is because the amount of the sand column above the bell that opposes the movement has decreased. Thacker et. al,[5] used model heaps with a cylindrical and belled shape to conduct 24 sets of vertical uplift loading experiments on single piles and pile groups in triangular (2x1 piles), diamond (2x2 piles), and square (2x2 pile) patterns. The piles were constructed of concrete (M20), had a 20mm diameter, and varied L/d ratios of 18, 20, and 22. In all belled pile studies, the length of the belled component was maintained at 40 mm while the diameter at the base of the piles was maintained at 2 times the pile's diameter. The individual piles and pile groupings are buried in a bed of dry sand. For the original experiment, the relative density was remained at 0%, and subsequently it was changed to 50% to understand the soil's density's influence. The L/d ratio, relative density, and the size of the belled part all affect the uplift load bearing ability. For all l/d ratios, belled piles had a greater uplift load bearing capability than cylindrical piles. For all l/d ratios, belled piles with a square pattern and a l/d ratio of 22 and relative density of 50% have the highest uplift capacity, making the belled square pattern the most beneficial. Liu et. al.

[1]Field prototype tests have been carried out for under-reamed piles bearing uplift loading in the loess of droughty area. In these tests, uplift displacement and horizontal displacement of under-reamed piles bearing uplift loading and horizontal loading, displacement of surface layer soil, and relationship of loading and displacement were measured. The ultimate uplift bearing capacity and failure mechanisms of piles were studied. It is very effective on improving ultimate uplift bearing capacity of pile to raise height of belled-out section of under-reamed piles. Strength failure mechanism of pile and soil is solved by gradual failure to be due to damage softening and reduction pressure softening of the soil. A theoretical model has been proposed to calculate the ultimate uplift bearing capacity in the loess, and comparing the calculation results with the test data, both are basically similar, which shows to have chosen correct calculation pattern. Yang et. al,[4]presents the field pull out test findings of the 500 kV double-circuit line of Luping-Fule to study the uplift bearing behaviour of the rock-socketed belled short piles. A rock-socketed belled short pile computation model has been put out. The bell of the pile continues to carry uplift load after the lateral resistance of the even section pile reaches its maximum during the initial stage of the loading test. On the case

of the lengthy belled pile, a different performance was discovered. For the 6.0 m long and 7.0 m long piles, respectively, the uplift resistance offered by the bell accounts for around 54.9% and 34.7% of the overall uplift capacity at the final condition. extending the pile's length has been shown to have a minimal impact on the displacement of the pile top but significantly increases the eventual uplift carrying capacity. The shear strength of the rock mass around the pile is correlated with the uplift capacity of even section piles, and test findings show that the ultimate resistance can be equivalent to the shear strength. The eventual uplift carrying capacity of the rock-socketed belled short piles may be precisely predicted using the calculating approach suggested in this study.

LAB MODEL AND PILE MATERIALS

The following Lab test was conducted at Geo-technical laboratory of Birla Vishwakarma Mahavidyalaya College, Anand district, Gujarat. The aim of conducting laboratory test is to get idea about behavior of different material of piles under pull out test as well as in different soil conditions. Furthermore, soil tests were also performed to get the soil parameters which are been used to for calculations. Soil test, namely Box shears test, Standard Proctor test and sand cone test. Pile materials which are used in this test are Concrete and Steel pile. The dimensions of steel pile are 35cm length and 5cm diameter and dimensions of concrete pile are 50cm length and 5cm diameter. Test was performed in dry sand as well as sand with 8% moisture content. Laboratory model consists of container of size 50x50x50cm, proving ring (1 division = 13.423N), two dial gauges, screw driver, wire string and a pulley. Average displacement recorded under pull out test. For the purpose of validation, different tests were performed in laboratory to know the behaviour of soil and piles. The tests performed are described in ensuing paragraphs. Types of tests performed are as follows:

- **Test on soil**
1. Sieve analysis
2. Box Shear Test
3. Standard proctor Test
4. Sand cone test.

- **Pull out test on different pile materials**
5. Concrete pile
6. Steel pile

- **Pull out test for pile under different soil conditions**
1. Pull out test in dry soil
2. Pull out test in soil with 8% moisture content

TESTS ON SOIL

A. Sieve Analysis

Sieve analysis of fine aggregate is utmost important test which is executed on site. Aggregates are inert materials that are mixed with binding materials such as cement or lime for the manufacturing of mortar or concrete. It is also used as fillers in mortar and concrete. Aggregates size varies from several inches to the size of the smallest grain of sand. All Aggregates pass IS 4.75 mm sieve is classified as fine Aggregates (according to IS 383-1970) [13]. For laboratory test purpose, sand sample was collected and passed through 4.75mm sieve. Thus, it can be classified as fine aggregate.

B. Box Shear Test

Failure in soils usually occurs on a specific surface (shear plane) in opposition to other material, like concrete or metals. The failure occurs when the shear stress, acting parallel to that surface, exceeds the shear strength. In the case of shear stress acting on a body, the deformation which is produced is called shear strain. In direct shear tests, shear strain is measured as the displacement between the two portions of the soil specimen. Shear strength may be defined as resistance against shear failure. Shear strength in soil develops due to friction & interlocking between partials (Φ) and electric charge (cohesion). Shear strength is not a fundamental property in soils as it depends on the in-situ

conditions, such as density, moisture, stress state etc. The value measured in the laboratory is likewise dependent upon the conditions imposed during the test and in some instances upon the duration of the test. Therefore, it is important to apply similar conditions in the laboratory as in the field. Box shear test is also known as direct shear test. It is easy, quick and inexpensive test. Here, there is no control over drainage; this test is always drained test. It is suitable for high permeable soil such as sand and gravel.

C. Standard Proctor test

Standard Proctor Test is carried out to study or understand the soil's compaction characteristics with variable moisture content. The test is performed to estimate the maximum load the soil could bear hence ultimately reducing the voids present in the soil. Compaction can be defined as, the densification of soil by application of mechanical energy known as compaction. It is a process by which soil molecules arranged more closely, the volume of air get reduce and density of soil increased. Proctor compaction test measures the maximum unit load that a particular type of soil can be compacted to use a controlled compact force at optimal water content. It is the most common laboratory soil test and is the basis for all engineered compact soil placements for embankments, pavements, and structural mills. The results of the Proctor test are compared to the measured densities of the compacted filled space to determine the degree of soil density.

D. Sand Cone test

Sand Cone test is a compaction test to measure density of soil in the field. One can obtain in-situ density of natural soil. The test is suitable for determination of the dry density of compact, fine, and medium-grained soils. Engineers use this test as a quality control procedure. Sand Cone Test is a need for cases where compaction is required like abutments, embankments, and pavement construction. Sometimes, you need to determine the bearing capacity of soils like for slope stability analysis or for determination of pressure on the underlying strata or for calculation of settlement during design of underground structures.

C. Results of Standard Proctor Test

Dia of mould = 10 cm, Height of mould =12.7cm, Volume =1000 cm^3, W_m =4.851 Kg

PULL OUT TEST ON DIFFERENT PILE MATERIALS

A suitable set up shall be designed to provide a proper uplift force to the pile. The load increments and the consequent displacements shall be as per the case of a vertical load test.

The safe load shall be the least of the following:

2/3rd of the load at which the total displacement is 12 mm or the load corresponding to a specified permissible lift. Half of the load at which the load displacement curve shows a clear break. Pull out test was performed to check the behavior pile under tension force as well as to know the uplift capacity of pile in sand. For testing purpose, steel pile and concrete pile were chosen. Laboratory set up, test procedure and result are shown further. The uplift load is applied by rotating bottom screw of proving ring gradually, which develops tension in the string and pile is subjected under pull out force. Readings shall be taken in field sheet at regular interval of time do that load vs. displacement graph can be obtained. Load can be directly calculated by knowing the number of divisions of proving ring. As per calibration data of proving ring, uplift force can be calculated from number of divisions. Here, 1 division = 13.423N.

SUMMARY OF RESULTS

1. The soil is classified as sandy soil as the value of cohesion is zero (c=0).
2. The optimum moisture of the soil is 8% with γd = 1.672 kN/m3.
3. The maximum Pull out capacity of steel pile in dry sand is 416.39N.
4. The maximum Pull out capacity of steel pile in partially saturated sand is 496.98N
5. The maximum Pull out capacity of concrete pile in dry sand is 214.912N
6. The maximum Pull out capacity of concrete pile in partially saturated sand is 268.64N

CONCLUSION

1. The lab work is intended to give the insight and detail characteristics of soil. Moreover, prior to any design, parameters are requiring for calculation. Thus, laboratory works is mandatory before commencing any design.
2. From sieve analysis we get to know the category of soil. For example, when samples collected from field, when checked in laboratory using sieve analysis, it gives us classification of soil.
3. Box shear test is required to find the shear strength parameters which are further require in calculation for designing any foundation.
4. Sand cone test provide in situ density of field, so an engineer on field get to know the density whenever required.
5. Here, I found the characteristics of pure sand by performing certain amount of test. Also, since I would be working on filed for pile foundation, I performed pull out test to know the behavior of pile under tension. So, I can give some advice on filed if same characteristic shown up.
6. So, it can be said that if an engineer knows the basics of laboratory test, then he/she might put an assumption before making any decision or undertaking any designing or execution works.

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Test in Dry Sand
Table.1 Results of Box Shear test

SR. no.	Normal stress(σ) (Kg/cm²)	Shear stress(ζ) (Kg/cm2)
1	0.1	0.168
2	0.2	0.24
3	0.3	0.305
4	0.5	0.55
c=	0.0518	
φ° =	43.82	

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Test in sand with 8% Moisture Content
Table 2: Results of Box Shear test on partially

SR. no.	Normal stress(σ) (Kg/cm²)	Shear stress(ζ) (Kg/cm2)
1	0.1	0.152
2	0.2	0.24
3	0.3	0.336
c=	**0.0578**	
φ° =	**42.61**	

Results of sand cone test
Table.3 Results of sand cone test

	Test 1	Test 2
Wet Weight of soil (gm)	408	104
Dry Weight of soil (gm)	371	100
Height of sand cone (cm)	3.2	2.877
Height of cone (cm)	2.3	2.3
Dia (cm)	12	12
Area (cm²)	113.04	113.04
Volume of sand cone (cm³)	361.728	325.2161
Volume of cone (cm³)	259.992	259.992
Diff in volume =	101.736	65.22408
γ_w (gm/cm³)=	**4.01038**	**1.594503**
γ_d(gm/cm3)=	**3.646693**	**1.533176**
% COMACTION =	91.53	%

$$percentage\ compaction = \frac{\gamma d(lab)}{\gamma d(insitu)} * 100$$

Note: Results in red colour were inaccurate due to human error in lab thus test was performed again.

Table.4 Result of concrete pile in dry sand

Pile Information					
Pile TypeMaterial	Concrete	Length	50 cm		
Soil Type	Sand (0% M/C)	Diameter	5cm		
Sr.No	**Revolution**	**Force (N)**	Displacement		**AVG.**
			DG1	DG2	
1	0	0	0	0	0
2	2	26.864	0.05	0.04	0.045
3	2	53.728	0.11	0.1	0.105
4	2	80.592	0.27	0.27	0.27
5	2	107.456	0.46	0.45	0.455
6	2	134.32	0.76	0.74	0.75
7	2	161.184	1.29	1.26	1.275

8	2	188.048	2.05	2.02	2.035
9	2	**214.912**	5.08	5.03	**5.055**
10	2	161.184	10.1	9.82	9.96
11	2	161.184	15.28	15.53	15.405
12	2	161.184	21.58	20.83	21.205
13	2	134.32	30.88	30.1	30.49
14	2	134.32	42.59	41.79	42.19
15	4	80.592	50.72	49.88	50.3
16	1	67.16	60.08	59.26	59.67
17	1	40.296	69.99	68.08	69.035
18	2	0	79	78.28	78.64
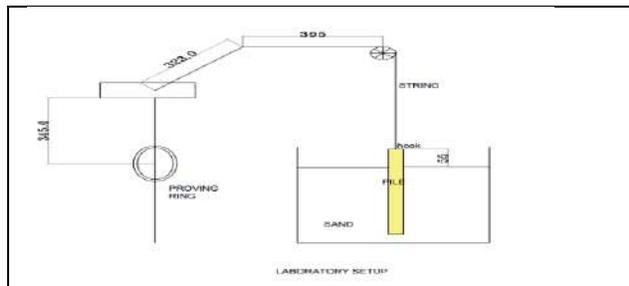
Fig.1 Laboratory Setup

Fig. 2 Performing Sieve analysis in lab

Fig. 3 Performing box shear test

Fig. 4 Weighing mechanism in proctor test

Fig. 5 Performing standard Proctor test

Fig. 6 Sand cone test laboratory setup

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Fig.7 Dia Gauge
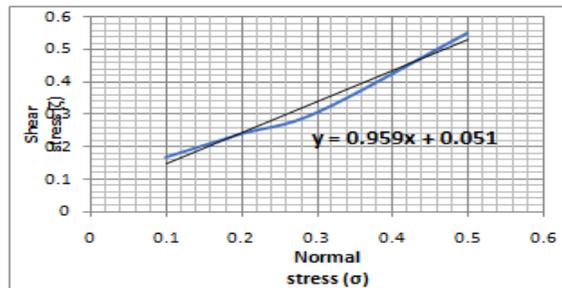
Fig.8 Result of box shear in dry sand
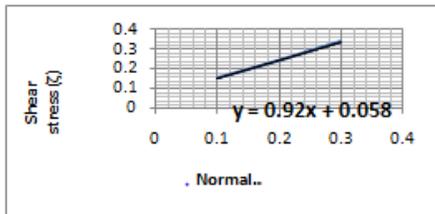
Fig.9 Result of box shear in sand with 8% M.C
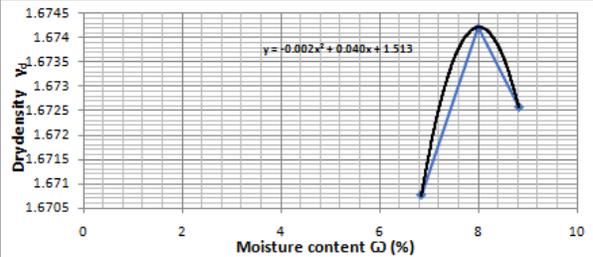
Fig.10 Results of Standard Proctor Test

Fig.11 Pull-out test of Concrete Pile

Fig.12 Pull-out test of Steel Pile
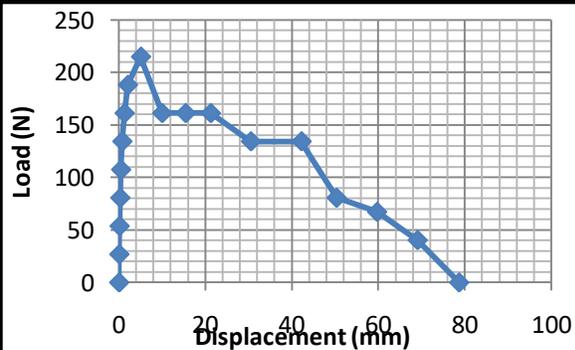
Fig.13 Result of concrete pile in dry sand
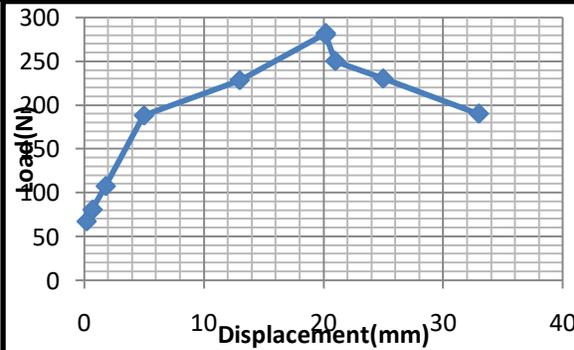
Fig.14 Result of steel pile in dry sand

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Fig.15 Result of concrete pile in partially saturated sand

Fig.16 Result of steel pile in partially saturated sand

RESEARCH ARTICLE

Productivity Improvement for a Manufacturing Process of Bearing Plate

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ABSTRACT

In basic terms, productivity is defined as a measure of efficiency of an organization assuming the same amount of inputs are given and achieve a maximum output with least wastage of resources and time. Therefore, every organization strives towards achieving more productivity in their manufacturing process which will in turn provide better quality to their customers. There are several areas in industry in which productivity can be improved such as improvement in facilities for manufacturing, reduction in men and material movement , improvement in material handling, change in layout to carry out operations without any disturbance or delay, improvement in ergonomics and safety of workers. This project addressed to set up a facility for manufacturing of Bearing Plate in Casting Industry using sand casting with maximum productivity by utilizing the various Industrial Engineering techniques which will allow them to achieve a desired production rate which will be economical and reliable for the organization.

Keywords: Casting, Plant Layout, Time Study, Motion Study, Productivity, Material Handling

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INTRODUCTION

It's great to see appreciation for the importance of casting in manufacturing and its historical significance. Casting indeed played a crucial role in the industrial revolution and continues to be a fundamental process in modern manufacturing. Casting involves the process of creating objects by pouring molten material, typically metal, into a mold where it solidifies and takes the shape of the mold. This method allows for the production of complex shapes that might be difficult or costly to achieve through other manufacturing processes. The formatter will need to create these components, incorporating the applicable criteria that follow. Suryadeep Alloy Steel Casting deals with all types of alloy steel casting manufacturing. With decades of practical experience, this industry has been an industry leader among the other casting industries in Vitthal Udyognagar, GIDC Anand. The companies look after improving their productivity through finding the solutions to the problems causing the productivity of an organization. Therefore, companies desire to produce the most output by effectively utilizing the available resources; and Suryadeep Alloy Steel Casting Ltd. is one of them. The problems which affected the productivity of Suryadeep Alloy Steel Casting ltd. The company has an ineffective layout, material handling problem, excessive men and material movement and ergonomics. Therefore, the objective was to enable the Suryadeep Alloy Steel Casting company with application of various Industrial Engineering Techniques so that the manufacturing of Bearing Plate can be carried out with maximum production rate.

MATERIALS AND METHODS

Problem Identification in Manufacturing Process of Bearing Plate and enabling the organization with Industrial Engineering Techniques to improve productivity.

LITERATURE REVIEW

According to Mayank Dev Singh (2015), In this research paper, the casting company which manufactures different mechanical components is facing issues related to the overall production process and productivity due to improper arrangement of resources and facilities. Therefore, the paper has suggested different industrial engineering techniques to improve productivity of plant. According to Cindy Sithole and Peter Olubambi research paper (2019) named Process knowledge for improving quality in sand casting foundries shows how the process knowledge, process variation, process sustainability and quality can be improved is shown by utilizing or implementing Six Sigma DMAIC framework. Ravi Mahetaa, Kavin Patela, Dishant Mehtaa, Manan Patel authored paper describes the data is collected to study the reasons for occurring defects , then after analyses the defects and with the help of barcode system they can identify that which component has not undergone the specific operation due to that defect occurred so that they can solve that immediately and will increase the production rate of non-ferrous casting. Kgashane Stephen Nyakala, Mbali Yvonne Moore, Kemlall Ramdass authored research paper explains various Industrial Techniques such as 5S methodology, Lean Manufacturing System and PDCA Cycle and provides a solution to implement PDCA cycle to reduce wastage of the material and improve quality and productivity.

Problem Identification

In this Industry, in one shed, the sand mixing is done using OMEGA mixer and moulding operation also carried out in the same shed, then after in the main shed where Induction Furnace is located where pouring is carried out, riser-cutting, grinding, shot blasting takes place in Fettling area in same shed, then after it moves to the Machining shed where the finishing operations are performed and then again it travels back to the main shed, and then it is dispatched. The main issue where the organization is facing is excessive men and material movement which led to increase in lead time. Therefore, to manufacture Bearing Plate with maximum production rate, a required facility

needs to be set up in a manner which involves every operation for casting that would be performed in the same premises of the organization.

Ineffective Layout

The current layout is not feasible for achieving higher productivity because the moulding takes place in a different shed than a pouring shed. The moulds are transferred from the moulding shed to the main shed through a vehicle. The distance between two sheds is 500m. This increases the lead time of the product.

Men and Material Movement

The movement of manpower increases due to the transporting of the material or the product from one shed to another shed. This creates fatigue and exhaustion to the manpower. The plant area suffers from a lack of organized material arrangement and an inefficient flow of materials. This leads to improper material movement, including instances of backtracking. Consequently, a greater distance is traveled by materials, resulting in increased travel time and related delays.

Material Handling

The materials and product are handled only with the help of a crane but, the movement of the product only with a crane is time consuming. Raw materials, semi-finished products, and finished goods need to be repeatedly transported between locations, but they are currently organized in a disorganized fashion. As a result, this process requires significant manual labor and consumes excessive time.

Manual Process

Currently, within the casting company, the majority of procedures are carried out using manual methods. There is an absence of partial or complete automation integration. Consequently, there is an increased expenditure of effort and time in executing tasks and accomplishing them. Moreover, the manual operations necessitate a workforce with specific skills.

Existing Layout

In Existing Layout, first the Sand is mixed using an OMEGA Mixer composed of 1.4% Resin, 22%Hardener, 46.8 % Fresh Sand and Reclaimed Sand. Then the moulding takes place by placing the pattern in the cop and drag and by extracting sand directly from the machine. Then after, the ramming of mould takes place. The Mould Curing operation was carried out in the same shed where the moulding takes place. But, Mould is kept in a moulding shed for up to 12 hours before it goes to the production shed. That time is idle time for mould of the Bearing Plate. Therefore, it creates a bottleneck situation or delay for Bearing Plate because moulding takes place in different sheds. Further, the mould is transported to the production shed and then the mould is unloaded from the vehicle and placed on a Shop Floor. Refractory Paint is applied with the help of paint brush to one mould at a time and then the preheating of the mould takes place using gas flame to one mould at a time before the assembly of Cope and Drag operation takes place. After that, the scrap is melted in an Induction Furnace and then it is poured in a mould. It is allowed to solidify for 4 hours. The moulding takes place in a different shed, the mould remains idle for at least about 12 hours in a Moulding shed itself because there is not enough space in a production shed for moulds accomodate on a mould line. Therefore, the limited production of the bearing plate can be carried out in an actual layout. The Production of Bearing Plate is limited upto the 90 plates per day in a current layout. The Refractory Paint is applied using the paintbrush manually on an inner surface of copper and dragged one at a time after the mould comes to a production shed. This takes 4 mins to paint a single mould at a time and it takes a lot of time to paint all the moulds and till then the melting of the metal cannot be carried out since all the moulds are not simultaneously painted Similarly, the pre-heating of the mould is carried out using the gas flame with the help of a gas cylinder connecting a rod which takes at least 5 mins to pre-heat a single mould. Therefore to pre-heat the 50 moulds placed on the mould line takes atleast 250 minutes to carry out this operation. Hence, this takes a lot of time and creates a fatigue for labor because the cylinder has to be carried out along the mould.

DATA ANALYSIS IN EXISTING LAYOUT

Time Study Table for Existing Layout

Bottleneck situations arise in these operations due to a 12-hour idle period where the molds are left waiting under the Moulding shed before being transported to the Production Shed for the pouring process. Subsequently, a single worker meticulously applies paint to each mold individually using a paintbrush, a task that consumes 4 minutes per mold. Additionally, another worker uses a gas cylinder to preheat the molds with gas flames, and this operation is also conducted by a single individual. These time-consuming and intricate tasks present challenges in the shop-floor environment.

Motion Study in Current Layout

In the existing manufacturing process of bearing plates, there is significant movement of both manpower and materials. Initially, the pattern is relocated to the moulding shed for the moulding process. Subsequently, the moulds are transported to the production shed using a tractor. Upon arrival at the production shed, a team of at least 2-3 workers employs a crane to unload the moulds, placing them onto the mould line. Following this, the solidified moulds are shifted to the knock-out area, where riser cutting occurs near the knock-out machine. Finally, the components are once again moved, this time to the fettling area. This process involves multiple stages of handling and movement, which can be optimized for efficiency.

Material Handling in Existing Layout

In the existing layout, material handling primarily relies on cranes to relocate molds between various locations and onto the mold line. Additionally, cranes are employed to position molds onto a vibrating machine for the knock-out process. After riser cutting, workers are typically responsible for manually moving components to the fettling area. However, it's worth noting that material handling using cranes can be time-consuming due to the limited crane speed, as each crane can only cover a distance of 14 meters. Consequently, there are inherent limitations associated with the use of cranes in this context.

Suggestions

Refactory paint application is efficiently executed using spray painting, which is considerably more convenient than manual brush application. It not only saves time but also reduces worker fatigue. In this process, molds are placed on a conveyor belt line, allowing for a continuous and consistent rate of paint application. As a result, it only takes approximately 2 minutes to paint each mold using the spray painting method. Pre-heating is efficiently accomplished using an Infrared (IR) Oven with dimensions of 8 meters in length and 4 meters in width. This oven is designed to accommodate up to six molds simultaneously, streamlining the pre-heating process. Remarkably, it takes just 20 minutes to complete the pre-heating procedure in a single cycle. Notably, this operation requires no manpower intervention, as it follows a well-coordinated sequence: molding, curing, paint application, and then automatic conveyance of molds to the IR oven for pre-heating.

Material Handling in Suggested Layout

In Suggested Layout, all the operations are carried out in a same shed and the for material handling the conveyor belts are for movement of moulds from moulding area to the paint application point and then after moved to the IR Oven for pre-heating. Further, the mould is placed on a mould line using the mould lifter equipment. This makes it easier and hassle free for carrying out a casting process without any interruption and less fatigue to the manpower.

Time Study in Suggested Layout

Data Analysis in Suggested Layout

In the proposed layout, all the essential manufacturing processes are consolidated under a single roof for improved efficiency and streamlined operations. The process begins with mold creation and sand storage, both housed in the same shed with dedicated silos. Molding is then carried out with the assistance of specialized machinery, and the molds are subsequently placed on a conveyor system for curing. After the curing process, thorough inspections are conducted to ensure the molds are ready for the Refractory Paint Section, where a spray painting technique is employed for efficient paint application. The final stages of the manufacturing process, including riser cutting, fins

grinding, runner grinding, finishing, and shot blasting, are all carried out within the same Fettling area within the same shed. This consolidated layout enhances production efficiency and facilitates seamless workflow throughout the manufacturing process.

Reduction in Lead Time in Suggested Layout

In the current layout, these operations resulted in bottleneck situations, causing a significant increase in the lead time for bearing plate production. However, in the proposed or new layout, all necessary facilities are consolidated under a single shed. As a result, there is no need for the transportation of molds, completely eliminating idle time and the waiting period for molds. This fundamental change in the layout is expected to have a substantial impact on the lead time for bearing plate production when compared to the current layout.

Motion Study in Suggested Layout

In Suggested Layout the pattern is moved from Pattern Shop to Moulding Area for moulding by manpower, then after the mould curing the mould is placed on a conveyor belt with the help of material handling equipment- lifter where the paint application and pre-heating of mould takes place on a same conveyor line. Further, it is placed on a mould line with the help of a crane. Then after, the components are moved to a knock-out machine for de-coring and then it moves to a fettling area for finishing operations.

Comparison

Hence, in Current Layout, the distance covered during the process is more in comparison to the distance covered during the process carried out in the proposed layout as the pattern has to be moved first for moulding and then it comes back to the production shed for pouring operation. Whereas, if these operations take place in a same shed where all the facilities are brought under the one shed then the distance or the motion would decrease by 80%. Whereas, in the Proposed Layout, the belt conveyor, lifter and forklift are introduced to allow material to move from one place to another. This will reduce the men and material movement, also, material handling becomes easy and reduces the fatigue of labour.

CONCLUSION

The company originally operated with two separate sheds for the casting process of Bearing Plates, resulting in an inefficient layout. This layout required significant movement of both personnel and materials, particularly when transferring patterns from the main shed to the moulding shed and subsequently bringing the molds back to the shop floor. This extensive travel covered a distance of 600 meters. However, with the introduction of a proposed layout and careful planning, including work and motion studies, the distance has been drastically reduced to just 20 meters. This reduction has led to an impressive 95% decrease in the lead time for each Bearing Plate and an 80% reduction in travel distance.To optimize material handling and eliminate improper material movements, the company has incorporated equipment such as forklifts, mould lifters, and belt conveyors. This has not only streamlined operations but also reduced worker fatigue. Addressing these issues has had a significant positive impact on both lead time and production rates within the organization. The application of Industrial Engineering Techniques has substantially improved plant productivity and the overall manufacturing process. It's important to note that while implementing the proposed layout and acquiring additional equipment like conveyor belts, forklifts, pallet trucks, and other material handling tools may require a substantial initial investment, these resources can be effectively utilized for manufacturing other products, ultimately enhancing overall productivity and efficiency.

ACKNOWLEDGEMENT

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Fig. 1.A. Bearing Plate Image	Fig 1 B. Bearing Plate Part Print

Symbols	Meaning
●	Operation
■	Inspection
D	Delay
▼	Storage
➡	Transport

Fig 1 C. Flowchart

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Fig .2 . Existing Layout

Fig. 3(a)- Different Shed,

Fig. 3(b)- Refractory paint

Fig. 4. Pre-heating of the mould

Fig. 5. Data Analysis In Existing Layout

Fig. 6. Bottleneck Situation

Fig .7. Fishbone Diagram

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	Fig.8. Motion Study in Current Layout	Fig .9 Material Handling in Existing Layout

Fig.8. Motion Study in Current Layout

Fig .9 Material Handling in Existing Layout

Fig. 10(a) Suggested Layout,

Fig 10(b) Infrared (IR) Oven

Fig. 11. Refectory Paint

Fig .12. Material Handling in Suggested Layout

Fig .13. Time Study in Suggested Layout

Sr No.	Description	Time in Min.						Average Time in min.	Remark
		1	2	3	4	5	6		
2	Idle Time	0	0	0	0	0	0	0	
3	Application of Refractory Paint	2	1.8	2.4	2.2	1.7	2	2.01	Spray Painting
4	Pre-heating of Mold	20	20.2	20.4	19.6	19.8	20.1	20.2	Using IR oven

Fig .14. Reduction in Lead Time in Suggested Layout

RESEARCH ARTICLE

Impact of Household Tasks on Musculoskeletal Health: Prevalence and Associations among Housewives

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ABSTRACT

Household tasks, especially for housewives managing domestic chores, are integral to daily life. This study examines how these tasks affect housewives' musculoskeletal health, emphasizing the prevalence of musculoskeletal disorders (MSDs) and their connections to different responsibilities. Household tasks, especially for housewives managing domestic chores, are integral to daily life. This study examines how these tasks affect housewives' musculoskeletal health, emphasizing the prevalence of musculoskeletal disorders (MSDs) and their connections to different responsibilities. A cross-sectional survey was conducted among a representative sample of housewives from diverse socio-economic backgrounds. Participants were queried about their engagement in a range of household tasks, including cleaning, cooking, childcare, and errands. Additionally, they were asked to self-report any musculoskeletal discomfort, pain, or disorders they experienced, particularly in the lower back region. The study uncovered a significant prevalence of musculoskeletal disorders among housewives. Household activities like cooking, chopping, dish washing, cloth washing, and cleaning were notably linked to lower back issues (p<.0001). Over a year, respondents reported lower back and knee problems (46.9%), followed by neck (31.3%), upper back (25.4%), shoulders and ankles/feet (14.1%), hips/thighs (13.6%), wrist/hand (12.9%), and elbow (10%) discomfort. Lower back pain was associated with heavy lifting, repetitive tasks, and poor postures (p<0.05). Further, pain in the wrist/hand and knee (P <0.05) was linked with awkward position and spending more than 8 hours a day doing homework. In addition, there was a relationship between repetitive work and wrist/hand pain (p<0.05). In addition, age was identified as a potential risk factor for work-related musculoskeletal disorders (p=0.016). Conclusion: This study highlights the impact of household tasks on housewives' musculoskeletal health. Many engage in extended chores with poor

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posture, leading to issues. Common tasks like cooking, cleaning, and lifting contribute. Preventive measures should focus on ergonomics and proper body mechanics for such activities

INTRODUCTION

Low back pain is a frequently encountered musculoskeletal issue that can manifest as either acute or chronic discomfort. It can stem from a variety of diseases and disorders affecting the lumbar spine. This type of pain is typically localized below the twelfth rib and above the inferior gluteal creases and may or may not be accompanied by pain radiating into the legs. Low back pain can be categorized as either "specific" or "non-specific," with the latter being more common. Chronic low back pain (CLBP) is a particularly significant medical and social concern and stands as one of the leading causes of disability. (1)In Bangladesh, the prevalence of low back pain among housewives is notably high, estimated at 58.6%. A study titled 'Women's contribution to the national economy' in Bangladesh unveiled that a substantial 81% of women are actively engaged in household duties.(2) These women dedicate a staggering 16 to 20 hours each day to various domestic chores, spanning approximately 45 different tasks. The research findings suggest that these housewives have no respite or leisure time whatsoever. In rural areas, women often shoulder an even heavier burden, being involved in tasks like agricultural activities, livestock and poultry farming, handicrafts, cooking, water collection, house cleaning, family care, and many other responsibilities. (3)In India, occurrence of low back pain is also alarming. Nearly 60% of women in India have significant back pain at some time in their lives. Epidemiological studies provide important information regarding various risk factors like age, sex, occupation, life style, socio-economic status & smoking habit. Few studies report that female patients experience more pain. The reason may be their more physical activities in workplaces and greater muscular effort (4).

A common finding was found that the prevalence of pain was higher in women. Prevalence of back pain of was 24.3% in women. Low back pain receives little attention and research in low-income countries compared to industrialized countries. Many studies have been done in urban areas which show a high prevalence of LBP in housewives (5). As the working, living and social architecture in the rural areas significantly differ from urban area (6). Household chores have historically been predominantly undertaken by women, constituting unpaid labour. These tasks encompass routine and obligatory household upkeep activities such as cleaning, cooking, laundry, lifting, shopping, and more. Additionally, they encompass family care responsibilities, including child-rearing and various care giving tasks that demand considerable physical, emotional, and intellectual effort.(7) Surprisingly, studies have revealed that housework can be more physically demanding than certain paid employment positions.(8) It presents hazards akin to those found in other occupational settings. Furthermore, research has identified correlations between housework and the development of upper-extremity and lower back disorders (9).

Housewives play a crucial role in managing household responsibilities, which often involve a wide range of physical activities. However, these daily tasks can take a toll on their physical well-being, particularly in the form of low back pain. Understanding the patterns of household activities and their effects on low back pain among housewives is essential for addressing this prevalent issue and promoting their overall health and quality of life. Household activities performed by housewives include cleaning, cooking, childcare, laundry, and more. These tasks often require repetitive motions, prolonged standing, and lifting heavy objects, which can strain the muscles and joints of the lower back. The combination of these physical demands, coupled with inadequate rest and improper body mechanics, contributes to the development of low back pain. Studies have shown that low back pain is a common problem among housewives, highlighting the need for a deeper understanding of the risk factors and contributing factors. Musculoskeletal imbalances, poor posture, and physical workload are key factors associated with low back pain in this population. Additionally, psychological factors like stress and emotional well-being can also influence the development and persistence of low back pain among housewives. Thus, this study aims to provide insights into

the complex relationship between household activities and low back pain among housewives. The findings will contribute to the existing knowledge on occupational health and assist in the development of targeted interventions and educational programs to promote musculoskeletal health among housewives. Additionally, the study will highlight the need for ergonomic considerations, risk awareness, and support systems that address the specific challenges faced by housewives in managing household responsibilities while minimizing the risk of low back pain.

Work-Related Musculoskeletal Disorders in the Lower Back Region among Housewives

Effects of potential risk factors like family structure, sociolect-economic status and educational level of housewives and social burden should study a give a better understanding of the problem. Furthermore, lower back pain should not be the only musculoskeletal disorder that studies among housewives. Every part of the body that might have the probability in getting musculoskeletal disorder should be studied among housewives. The study conducted by Gupta and Nandini (2015) sought to evaluate the prevalence of low back pain in non-working rural housewives and to delineate the impact of social burdens on low back pain (LBP). Their research incorporated a sample of 301 non-working rural housewives, aged between 30 and 70 years, hailing from Kanpur. Upon data analysis, a noteworthy prevalence rate of 83% for both recent and yearly occurrences of low back pain emerged among rural housewives. Furthermore, the investigation unveiled that more than half of the housewives endured severe disability stemming from their low back pain. The analysis highlighted contributing factors, including prolonged working hours bereft of sufficient rest intervals, poor posture, and improper techniques of lifting and carrying loads—factors contributing to physical strain. Evidently, the prevalence of back pain was remarkably pronounced within the cohort under study.

Notably, the challenges faced by housewives might be rooted in the adoption of forward bending and prolonged squatting postures, which could lead to discomfort. Additionally, the frequent twisting of the trunk during the execution of arduous tasks might potentially induce chronic strain due to spinal rotation. Kalra and Bhatnagar (2017) conducted a study with the aim of examining the prevalence of musculoskeletal disorders (MSDs) among housewives in Delhi and Noida. A cohort of 100 housewives, aged between 25 and 35 years, who were not pregnant, were selected to participate in the study. The findings of the research indicated that every single one of the participating housewives (100%) experienced musculoskeletal disorders affecting one or more regions of their bodies. The study revealed that the prevalence of these disorders manifested as lower back pain (60%), shoulder discomfort (42%), upper back issues (38%), neck pain (35%), wrist/hand ailments (29%), ankle/foot problems (26%), knee and thigh/hip/buttock discomfort (20%), and elbow afflictions (18%). Furthermore, these musculoskeletal disorders impeded the ability of housewives to engage in their routine activities. Notably, the study underscores the substantial impact of musculoskeletal disorders on the daily lives of housewives, highlighting the pressing need for interventions and support to mitigate these challenges.

MATERIALS AND METHODS

In this study, a cross-sectional observational design to examine the relationship between household activities and low back pain among housewives Residing in Vallabh Vidyanagar. All data collected from July 2021 to December 2021. The study included female participants, specifically housewives aged between 25 and 60 years, who were experiencing mechanical low back pain and expressed an interest in participating. Excluded from the study were subjects with severe neurological problems, osteoporosis, a history of heart disease, current pregnancy, employment or engagement in regular job or service, as well as individuals with general illnesses. The questionnaire employed in this study comprised three distinct sections;

Demography Characteristics

The demographic characteristics of the participants in this study were collected through a self-administered questionnaire. The questionnaire was distributed to a total of 110 participants. The information gathered included age, family income, marital status, level of education, and hours of paid work.

Modified IPAQ Questionnaire

The International Physical Activity Questionnaire (IPAQ) was adapted and modified according to the research's specific needs. The IPAQ is a well-established tool used to assess an individual's physical activity levels. Participants were asked about their physical activity habits, including the frequency, intensity, and duration of various activities they engaged in, such as walking, moderate-intensity activities, and vigorous-intensity activities.

VAS Scale

The Visual Analog Scale (VAS) is a subjective measurement tool commonly used to assess pain intensity and perception. Participants were asked to rate their pain levels on a horizontal line, with endpoints representing extremes, such as "no pain" to "worst pain imaginable." This scale allowed researchers to gain insights into the participants' pain experiences and provided a quantitative measure of pain intensity.

Data analysis

Descriptive Analysis: Frequencies and percentages were derived for categorical variables, while means/standard deviations were derived for continuous variables. Chi-square tests were used to assess any significant difference between demographic characteristics and the frequency of self-reported pain in each body region.

RESULTS

The study aimed to investigate the prevalence of low back pain among housewives. Through descriptive data analysis on a sample of 110 subjects, all of whom were rural housewives, the results revealed an average age of 48.55 years within the study population. When it came to the time they spent on household activities, more than half of the participants (53.7%) had been doing these tasks for 10 to 30 years whereas (30.2%) had been engaged in household activities for over 30 years. Furthermore, analysis also revealed that about 66% of the subjects devoted seven to nine hours to their regular household activities, on average. This suggests that a considerable portion of housewives have devoted many years to their domestic responsibilities. In this study, 89 homemakers self-reported musculoskeletal pain over a 7-day, 12-month, and 4-week period (Table 1). The prevalence of pain in different regions varied. Notably, lower back and knee pain were consistently high at 46.9%, followed by neck pain at 31.1% and upper back pain at 25.4%. Shoulder and feet discomfort affected 14.6% of participants, while hips/thighs discomfort was reported by 13.6%. Wrist/hand pain accounted for 12.9%, and elbow pain stood at 10%. This data illuminates the distribution of pain in different body areas and highlights areas for targeted intervention. (Fig 1) The number of participants seems to slightly exceed the study's population due to multiple responses to a single question.

The presented below table provides an in-depth analysis of household activities, detailing the responses, frequencies, percentages, Chi-square values and p-values. Out of the 110 participants, a significant majority, 80.9%, were engaged in cooking, while 68.1% were involved in chopping tasks. Washing both dishes and clothes was a common activity for 61% and 53.6% of the participants, respectively. These activities showed a significant association at a significance level of p<0.05 and a positive correlation with the Lower Back Region, as indicated in Table I. Furthermore, the percentage of individuals sweeping the floor and cleaning the bathroom/toilet was also significantly associated and positively correlated with the Lower Back region at a p value of less than 0.05. A substantial portion of participants, specifically 41.2%, performed their cooking tasks while standing, and 38.0% preferred a low sitting position. (Table I) The above results investigated the potential connections between household-related factors and musculoskeletal pain across various body regions (Table II). To establish these associations, both Chi-square and Fisher's exact tests were conducted. A critical p-value of less than 0.05 (typically ≤ 0.05) was employed, indicating robust evidence against the null hypothesis with a probability of less than 5% that the null hypothesis holds true. The results illuminated significant connections between specific household-related factors and pain in distinct anatomical regions. Notably, lower back pain (p<.05) exhibited a compelling association with the act of lifting heavy objects and adopting awkward postures. Similarly, knee pain (p<.05) showed a relationship with both extended working hours and awkward positions (Table II).   Further insights revealed a link between wrist pain (p<.05) and the nature of work

involving repetitive tasks, awkward positions, and heavy lifting (Table 2). Intriguingly, participants engaged in work for over 10 years displayed an elevated vulnerability to upper back pain (p<.05).

The association between age and occurrence of musculoskeletal pain was determined by using Chi square test. The age range which has the highest number of participants (83.3%) of getting work-related musculoskeletal disorders was above 45 years. The difference in the work-related musculoskeletal disorders between age range among housewives was statistically significant as p = 0.015, which stated that there was correspond between age and work-related musculoskeletal disorders. (Table III) As participants dedicate more time to their household responsibilities, a notable trend emerges. A considerable 64.4% of them feel bored due to these tasks, while a substantial 79% end up feeling tired by the day's end. These numbers underscore the widespread experiences of boredom and fatigue that can arise from prolonged involvement in household activities.

DISCUSSION

This cross-sectional study aimed to investigate musculoskeletal pain experienced by rural homemakers as a consequence of household tasks. Additionally, the study sought to uncover their approaches to seeking health assistance. Notably, the study's primary discovery highlighted a notably high prevalence of musculoskeletal pain across various body areas among homemakers. Specifically, the lower back, knees, neck, upper back, hips/thighs, and wrists/hands emerged as the most commonly reported locations of discomfort. This underscores the fact that pain resulting from indoor activities can affect any part of the body, either individually or collectively. The current study identified a significant proportion of participants engaging in a variety of household tasks, with notably high participation rates in activities such as cooking, chopping, washing clothes, sweeping floors, and cleaning bathrooms/toilets. These findings contrast with a previous study conducted in Bangladesh, where they observed higher participation rates among housewives in tasks like cleaning the house (92%), washing clothes (81%), child care (80%), cooking and meal preparation (81%), and tending to cattle (52%). It is important to note that these household activities often entail adopting awkward postures, such as prolonged periods of sitting or standing, bending, kneeling, squatting, and performing repetitive movements.[10] These activities necessitate various uncomfortable positions, including prolonged periods of sitting or standing, bending, kneeling, squatting, and repetitive movements. The principal discovery of this study underscores a significantly high prevalence of musculoskeletal pain in nearly all regions of the bodies of homemakers.

The most frequently reported symptoms were related to the lower back, knees, and neck, indicating that pain resulting from indoor activities can affect any part of the body, whether individually or in combination. On average, 46.9% of participants experienced low back pain and knee pain in the past 12 months, whereas 31.1% reported neck pain. The least commonly reported issue was discomfort in the elbow, which affected only 10% of participants in the same time frame. These findings align with those from previous studies conducted by Bhatnagar (2017), Mishra, Srivastava, and Srivastava (2015), Habib & Rahman (2015), Fazli et al. (2014), and Golam Kibria (2012). Kalra & Bhatnagar (2017) also found that the lower back was the most frequently affected body region, consistent with the results of this study. In contrast, Mishra et al. (2015) identified the feet/ankles as the most common site for musculoskeletal disorders among housewives. However, the study conducted by Habib & Rahman (2015) suggested that the feet/ankles were the least commonly affected body region in cases of work-related musculoskeletal disorders. Habib and Rahman proposed that the upper back was the body region most frequently affected by work-related musculoskeletal disorders. In 2014, Fazli et al. conducted a study aimed at determining the prevalence of musculoskeletal disorders among housewives. Their findings indicated that the back region had the highest prevalence of work-related musculoskeletal disorders among housewives. Furthermore, Golam Kibria's 2012 study identified that 46% of respondents reported experiencing lower back pain. Beyond the scope of this study, several other research efforts have demonstrated that lower back pain is associated with factors such as the number of children, age, educational level, work experience exceeding 10 years, awkward postures, and heavy lifting. In the

current study, age emerged as a significant factor in the association with work-related musculoskeletal disorders among rural housewives. Notably, the age group with the highest number of participants experiencing work-related musculoskeletal disorders was those over 40 years old. From my perspective, the decrease in muscle mass and bone density that occurs with aging, combined with the demands of various household activities, contributes to higher muscle fatigue rates, ultimately leading to work-related musculoskeletal disorders. This viewpoint is supported by the research of Sallehuddin et al. in 2018, which found that older obese housewives were at a greater risk of developing musculoskeletal disorders compared to their younger counterparts.

This was supported by Sallehuddin et al. (2018) that older obese housewife had higher risk of getting musculoskeletal disorders compared to a young obese housewife. Mishra et al. (2015) provided findings that aligned with the notion that age is a risk factor for musculoskeletal pain. In the present study, researchers observed that housewives experienced a sense of monotony due to the extended and repetitive household activities they engaged in. The study revealed that 64.4% of participants reported feeling this monotony, and 79% expressed feelings of exhaustion by the end of the day. Notably, a study conducted in Sri Lanka in 2016 corroborated these results, indicating that psychological distress was 1.8 times higher (95% CI=1.3–2.6) among housewives as a result of their household duties. In contrast, an Iranian study conducted by Fazli and colleagues found that housewives also experienced exhaustion due to the strenuous nature of their domestic work, which could potentially affect their posture while carrying out household tasks.

CONCLUSION

The prevalence of work-related musculoskeletal disorders among housewives is notably high when compared to other occupations. Therefore, it is crucial to prioritize awareness and medical attention for housewives in relation to these disorders. The potential risk factors associated with work-related musculoskeletal disorders include age, the duration of household activities, working postures, and lifting heavy weights. While these risk factors have shown associations, further investigation is necessary to establish causal relationships. It is imperative to educate housewives engaged in various household activities about the importance of incorporating sufficient rest periods and avoiding potential risk factors that could lead to injuries. By mitigating the occurrence of work-related musculoskeletal disorders, housewives can lead healthier lives, free from discomfort, and continue to care for their families effectively.

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Table I Association between Household Activities and Lower Back Region (N=110)

Household activities	Response	F	%	X^2	P value
Cooking	Yes	89	80.9	13.021	**.012***
	No	13	11.8		
Chopping	Yes	75	68.1	0.948	**.030***
	No	26	23.6		
Washing clothes	Yes	67	61	33.782	**.001***
	No	34	31		
Dish washing	Yes	59	53.6	6.098	**.042***
	No	42	38.1		
Sweeping	Yes	65	59	>0.001	**1.000***
	No	36	32.7		
Mopping	Yes	62	56.3	0.351	.553
	No	39	35.4		
Bath room/toilet cleaning	Yes	78	71	0.569	**0.45***

*Chi-square test was performed, Level of significant at p<0.05,

TABLE II : Association between Household Related factors and Musculoskeletal Pain in Different Site of Body Regions

Site of pain	P value			
	Repetitive work	Lifting heavy object	Awkward position	Working hours per day > 8 hours
Neck	.336>0.05	0.685>0.05	**.003*<0.05**	0.119>0.05
shoulder	1.00>0.05	1.00>0.05	1.00>0.05	1.00>0.05
Upper back	**.025*<0.05**	.065>0.05	**.001*<0.05**	1.00>0.05

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Elbow	1.0>0.05	1.0>0.05	1.0>0.05	1.0>0.05
Wrist/hand	**.021*<0.05**	**.011*<0.05**	**.04*<0.05**	.35>0.05
Lower back	**.00*<0.05**	**.003*<0.05**	**.002*<0.05**	.46>0.05
Thighs	1.00<0.05	1.00<0.05	1.00<0.05	.65>0.05
Knee	1.00<0.05	.1>0.05	***.003<0.05**	***.004<0.05**
Ankle	.057 <0.05	.124>0.05	.42>0.05	.49>0.05

Table III: Association between Age of the Respondents and Musculo skeletal Pain.

Age (in yrs)	Musculoskeletal pain		X^2	df	P-value
	Yes	No			
<30	08	102	14.026*	5	0.016*
30-40	38	72			
>40	64	46			
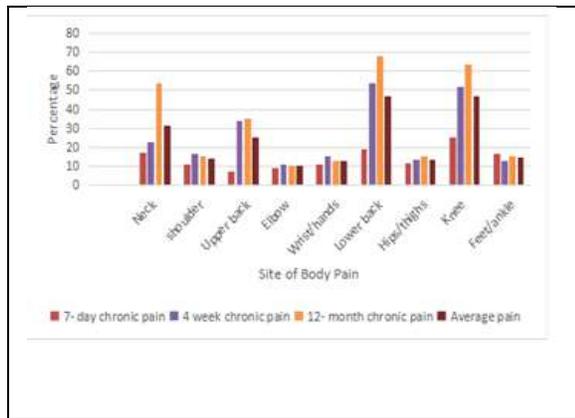
Fig. 1 Location of pain on the different site of the body in a given period	**Fig. 2 Percentage distribution of the psychological condition of the housewife**
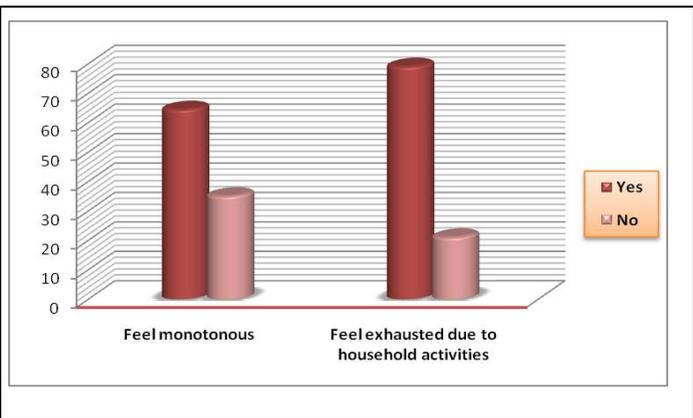
RESEARCH ARTICLE

Distributed Control in DC Microgrids to Improve Voltage Regulation and Current Sharing Accuracy

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ABSTRACT

At this time, the micro grid is the best solution of the conventional grid to reduce the use of fossil fuel and pollution. A DC micro grid is very popular compared to an AC micro grid because of high efficiency, high reliability and easy control. The main goals of DC micro grid control are equal load sharing among all sources and low voltage regulation. In a DC micro grid, generally droop control is used for equal load sharing among sources. There are two drawbacks of traditional droop control. (1) Reduce current sharing accuracy due to different line resistance. (2) Decrease DC bus voltage with increased load current due to droop action. The distributed secondary control method is used in this paper to improve the performance of DC micro grid. The main advantages of this control are: high reliability, equal load sharing among sources and improved voltage regulation. A MATLAB simulation was carried out to validate the performance of this method.

Keywords: distributed control; droop control; dc microgrid; voltage regulation; current sharing accuracy

INTRODUCTION

Recently, to reduce the global energy crises and serious environmental problems created by the use of fossil fuels, renewable energy sources like wind energy, photo voltaics, and fuel cells have become very popular and are combined within the power grid to work as distributed generation (DG) [1–4]. A micro grid concept is used to effectively manage these DGs. A micro grid is an integration of distribution generations (DGs), energy storage systems (ESSs), and local loads that can work in coordination to reliably supply electricity [5–6].

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Different types of micro grids have been mentioned in the literature. As per common bus voltage, the micro grid may be classified into three different categories: alternating current micro grid (ACMG), direct current micro grid (DCMG), and hybrid micro grid (AC/DC MG) [7]– [9]. A DC micro grid has some advantages compared to an AC micro grid, such as simple control, no reactive power, synchronization [10–11], and transformer inrush current problems [12]. Further, most of the renewable energy sources, energy storage devices, and loads are DC in nature, hence directly coupled to the DC bus. Which reduces the power conversion stages so characterized by high efficiency [13–15]. The simple structure of a DC micro grid is shown in Fig. 1, where a DC bus links the different sources and loads. A windmill is connected to the DC bus through an AC-DC converter. A solar panel and an energy storage system are connected through a DC-DC converter. A DC load and an AC load are also connected through a DC-DC converter and an AC-DC converter, respectively. A DC bus is also connected to the utility grid through a DC-AC converter. The structure of a DC micro grid is different from a radial or ring system utility grid [16]. Since all the distributed energy sources are connected to a common DC bus in the DC micro grid, the interfacing converters are connected in parallel. Control of the interfacing converter is a big problem in DC micro grid operation [17–18]. Primarily load current sharing among all distributed energy sources [19–20]. Several control techniques are offered in the literature for proper load current sharing in a parallel-connected converter, such as a circular current chain control [21], a master slave control [22], etc. Among all other techniques, droop control is commonly used as an effective load-current sharing method in a micro grid [23].

But droop gain greatly affects the performance of traditional droop control [14]. Which either causes poor voltage regulation or an inaccuracy in load current sharing. It means it is very tough to simultaneously achieve low voltage regulation and accurate load current sharing by using only the droop control. To solve these drawbacks, secondary control methods have been proposed in the literature [23]. In [23], secondary control of a DC micro grid is classified into two categories: centralized secondary control and distributed secondary control. A centralize secondary control method is proposed to eliminate the voltage deviation, but the effect of line resistance is not considered and also suffers from a single point of failure. In [24], a distributed secondary control method based on an average current controller is proposed to restore the DC bus voltage, but load current sharing accuracy is not enough. In [25], a control method based on average voltage sharing proposed to keep DC bus voltage at a reference value. In [26] proposed a control method to enhance the current sharing accuracy. In [27], an improved distributed secondary control method is proposed to restore a DC bus voltage and improve current sharing. It used three different controllers in the secondary loop. In [28-29] use cooperative control that reduce communication burden, but convergence speed is slow and required rigorous mathematical analysis. A distributed secondary control method is proposed in this paper to improve voltage regulation and current sharing accuracy in DC micro grids. It consists of two controllers in the secondary loop. voltage controller, to restore DC bus voltage at the reference value, and an average current controller, to ensure equal load current sharing among all converters. The MATLAB/Simu link software is used to validate the results of the proposed method.

Drawbacks Of Traditional Droop Control [14]
The traditional droop control method has mainly two drawbacks. First, due to the unequal line resistance, the output voltage of each converter is not equal, hence load current sharing accuracy is reduced. Second, output voltage is decreases with the increased load current due to the droop action. These two drawbacks are briefly explained as follows.

Reduce Current Sharing Accuracy
In DC micro grids, I-V droop controllers are used for load current sharing between all DGs. This regulator can be implemented using virtual resistors. This method is also called adaptive voltage positioning [26]. If the resistance of the line is considered, due to different line resistances, the voltage drops across them is also different, so the DC output voltage of all the converters is not exactly equal. Therefore, load-current sharing accuracy is reduced. Consider a two-node DC micro grid in which each converter is modeled with a thevenin equivalent circuit, as shown in Figure 2. The droop equation looks like this.

$$V_{dci} = V_{dc}^* - i_{dci} R_{droopi} \qquad \text{----------(1)}$$

where V_{dci} = output voltage of each converter, V_{dc}^* = reference value of the dc output voltage, i_{dci} = output current of each converter, R_{droopi} = virtual resistance and i = 1, 2.

According to Thevenin's equivalent circuit, as shown in Fig. 2, the output resistance is same as the virtual resistance, and the output voltage of the voltage source is same as V_{dc}^*. The following equations 2 and 3 are derived from Fig. 2.

$$V_L = V_{dc}^* - i_{dc1} R_{droop\,1} - i_{dc1} R_{L1} \qquad \text{----------(2)}$$

$$V_L = V_{dc}^* - i_{dc2} R_{droop\,2} - i_{dc2} R_{L2} \qquad \text{-------(3)}$$

Where, R_{L1} and R_{L2} are line resistance of the line-1and line-2 respectively.
The ratio of the output current of the converter,

$$\frac{i_{dc1}}{i_{dc2}} = \frac{R_{droop\,2} + R_{L2}}{R_{droop\,1} + R_{L1}} \qquad \text{--------(4)}$$

Set the output current of each converter is inversely proportional to their virtual (droop) resistance in conventional droop-controlled DC microgrid. So, from (4) the load sharing error are totally eliminated when following expression is satisfied.

$$\frac{R_{droop\,1}}{R_{droop\,2}} = \frac{R_{L1}}{R_{L2}} \qquad \text{------------ (5)}$$

Assume that, generally, in a DC microgrid, the system is small, therefore the value of line resistance is also small, so select a large value of virtual resistance. Then $R_{droop} \gg R_{L1}$ and $R_{droop} \gg R_{L2}$, from (2) and (3)

$$\frac{i_{dc1}}{i_{dc2}} = \frac{R_{droop\,2} + R_{L2}}{R_{droop\,1} + R_{L1}} \approx \frac{R_{droop\,2}}{R_{droop\,1}} \qquad \text{--------------(6)}$$

But the above equation is only satisfied for a small microgrid; the selection of large virtual resistance also raises system stability issues.

DC VOLTAGE DEVIATION

As per (1) in the droop control method, the voltage drop can be calculated by using the following:

$$\Delta V_{dci} = i_{dci} R_{droopi} \quad , \text{i=1,2} \qquad \text{-------(7)}$$

From above, say that if load current i_{dci} increases, voltage drop also increases, resulting in poor voltage regulation. For maximum allowable voltage drop, the value of the droop coefficient should not exceed the following:

$$R_{droopi} \le \Delta \frac{V_{dcmax}}{i_{dcfi}} \qquad \text{-------(8)}$$

Where, i_{dcfi} = full load output current of ith converter. Dropping the DC output voltage due to droop action is the second drawback of conventional droop control. In [28], large values of droop gain ensure equal load sharing, but small values of droop gain improve voltage regulation, so there is a trade-off between current sharing and voltage regulation in traditional droop control. That needs secondary control.

Principle of the Proposed Control Method

In this paper, to remove the drawbacks of traditional droop control, the distributed secondary control method is proposed, as shown in Fig. 3, in a droop-controlled DC micro grid. Here, buck converters are used for DC-DC

interfaces. The control method consists of three different controllers: an inner loop controller, a primary (droop) controller, and a secondary controller. The inner loop controller also consists of an inner voltage loop and an inner current loop controller, which controls the DC output voltage of each converter. The droop controller is used to generate the reference value for the inner-loop controller to ensure approximately proportional load sharing among all converters. The output currents (i_{dci}), of all the converters are shared with all other converters to calculate the average current (i_{av}), meanwhile, the DC bus voltage (V_{dcbus}), is also given to all converters as a feedback signal. The secondary controller compares the DC bus voltage to a reference voltage to generate a voltage signal δ_v. The average current is compared to the converter's output current to generates a current signal δ_i . These voltage and current signals pass through two proportional-integral (PI) controllers, which generate voltage error Δv and current errors Δi, respectively. Secondary control generates the reference for the droop controller.

Due to the secondary voltage controller, the DC bus voltage is restored to its reference value. Meanwhile, the average current secondary controller ensures proportional load current sharing among all converters. All the calculations are done locally; therefore, the proposed method is suitable for distributed secondary control in a DC microgrid. The proposed secondary control method is represented by the following equation:

$$V_{dci}^* = V_{dc}^* - R_{droopi}\, i_{dci} + k_1 - k_2$$

Were, $k_1 = \left(K_{pv} + \dfrac{K_{iv}}{s}\right)(V_{dc}^* - V_{dcbus})$,

$$k_2 = \left(K_{pc} + \frac{K_{ic}}{s}\right)(i_{av} - i_{dci})$$

Where V_{dci}^* the given reference value of the converter i, V_{dc}^* the reference value of DC bus voltage, R_{droopi} the droop coefficient of ith converter, K_{pv} and K_{iv} the proportional gain and integral gain of the secondary voltage regulator, and K_{pc} and K_{ic} the proportional gain and integration gains of the secondary average current controller, respectively.

SIMULATION RESULTS
MATLAB/Simulink software is used to validate the performance of the proposed secondary control method. Fig. 4 shown the study's micro grid system. It consists of two dc-dc buck converters connected in parallel to supply a common load. The system parameters are given in Table 1. Here, the resistance of lines 1 and 2 is 0.02 ohm and 0.08 ohm, respectively. To verify the performance of the proposed system, different resistive loads are connected to a common DC bus.

Case 1: 20-ohm resistive load Initially, at t = 0 sec, traditional droop control is applied. At t = 0.2 sec, the proposed secondary control is activated. In Figs. 5 (a), 5 (b), and 5 (c), the output current of each converter, the output voltage of each converter, and the DC bus voltage are shown, respectively.
Case 2:10-ohm resistive load Initially, at t = 0 sec, traditional droop control is applied. At t = 0.2 sec, the proposed secondary control is activated. In Figs. 6 (a), 6 (b), and 6 (c), the output current of each converter, the output voltage of each converter, and the DC bus voltage are shown, respectively. As shown in Figs. 5 and 6, when the proposed method is activated, the DC bus voltage is returned to approximately the reference value, so voltage regulation is improved and load current sharing error is reduced.
Case 3: Increase load current. At t = 0 sec, a 20-ohm load resistance is connected to the common DC bus, and the proposed secondary control method is activated. At t = 0.5 sec, increase the load current by connecting the 10-ohm load resistance. In Figs. 7 (a), 7 (b), and 7 (c), the output current of each converter, the output voltage of each converter, and the DC bus voltage are shown, respectively, with an increase in load current. Fig. 7 proves that the proposed method is still valid for increasing load current. The difference in output current of two converters and voltage regulation at different load resistances for traditional droop control is shown in Table 2, and for the proposed control, it is shown in Table 3.

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CONCLUSION

In this paper, to overcome the drawbacks of traditional droop control, a distributed secondary control method is proposed for DC micro grids. The performance of the proposed control method is verified for different line resistances and transient loads. It is shown that in the traditional droop control method with 10-ohm load resistance, the difference in output current between two converters is 13.15 A. When the proposed secondary control method is applied, this difference is reduced to 0.12 A. Both converters share almost equal load current, improving load current sharing accuracy. Meanwhile, in traditional droop control, DC bus voltage reduces from 400 V to 385.9 V when the proposed secondary control method is applied; this voltage is restored to 399.8 V, so in the traditional droop control method, voltage regulation is 3.53 %, while in the proposed method, voltage regulation is only 0.5%. Hence, equal load current sharing and good voltage regulation are achieved simultaneously.

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Table I System parameter

Parameter	Converter-1	Converter-2
Power rating	20 kW	20 kW
Output voltage	400 Volt	400 Volt
Switching frequency	10 kHz	10 kHz
Inductor	2.64 mH	2.64 mH
Capacitor	312.5 μF	312.5 μF
Droop gain	$K_1 = 2$	$K_2 = 2$
Line resistance	$R_{L1} = 0.02\Omega$	$R_{L2} = 0.08\Omega$
Secondary voltage loop	$K_{pv} = 50$	$K_{pv} = 50$
	$K_{iv} = 7$	$K_{iv} = 7$
Secondary current loop	$K_{pc} = 40$	$K_{pc} = 40$
	$K_{ic} = 7$	$K_{ic} = 7$

Table II Results of traditional droop control method

R_L	i_{dc1} (A)	i_{dc2} (A)	V_{dcbus} (V)	V_{dc}^* (V)	$i_{dc1} - i_{dc2}$ (A)	% Voltage Regulation
20 Ω	13.22	6.481	392.8	400	6.802	1.8
10 Ω	25.87	12.72	385.9	400	13.15	3.53

Table III Results of proposed secondary control method

R_L	i_{dc1} (A)	i_{dc2} (A)	V_{dcbus} (V)	V_{dc}^* (V)	$i_{dc1} - i_{dc2}$ (A)	% Voltage Regulation
20 Ω	10.05	9.959	399.9	400	0.091	0.025
10 Ω	20.07	19.95	399.8	400	0.12	0.05
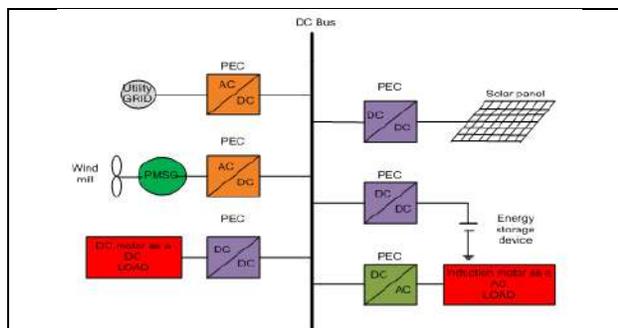
Fig. 1 Simple structure of DC micro grid	Fig.2 Load sharing by two parallel controllers
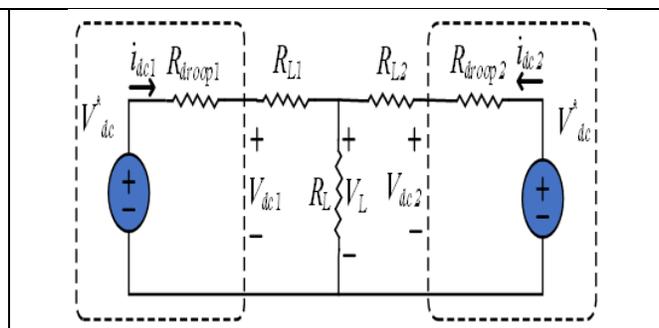
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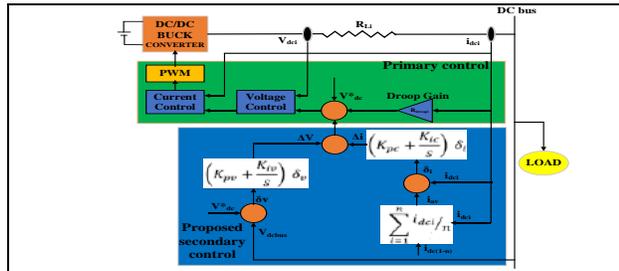
Fig.3 Block diagram of proposed secondary control method	**Fig.4 Proposed micro grid system**
Fig. 5(a) Output current of converters	**Fig. 5(b) Output voltage of converters**
Fig. 5(c) Bus voltage	**Fig. 6(a) Output current of converters**
Fig. 6.(b) Output voltage of converters	**Fig. 6(c) Bus voltage**
Fig. 7(a) Output current of converters	**Fig. 7(b) Output voltage of converters**
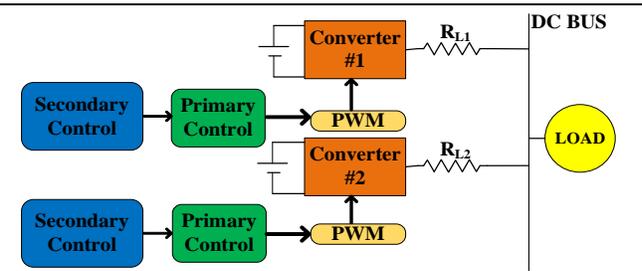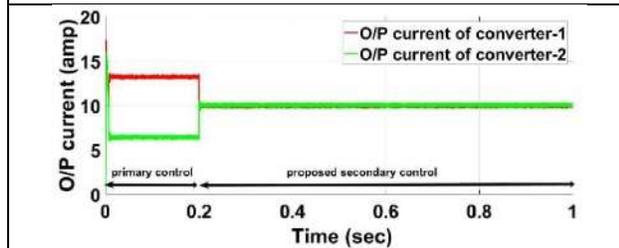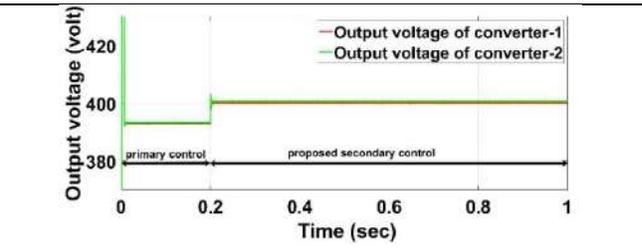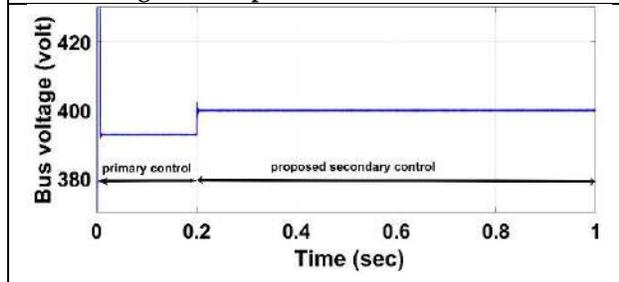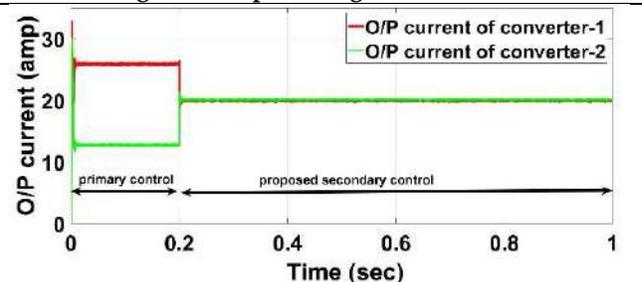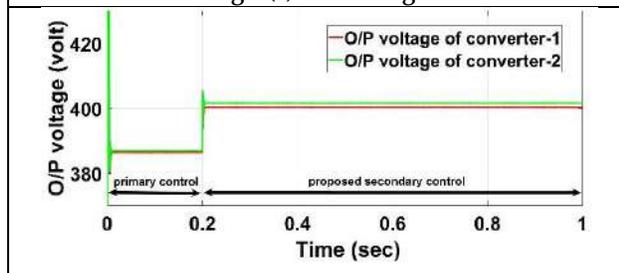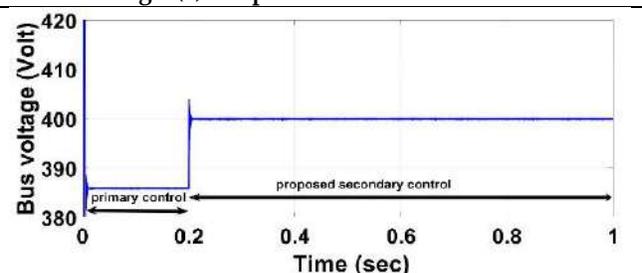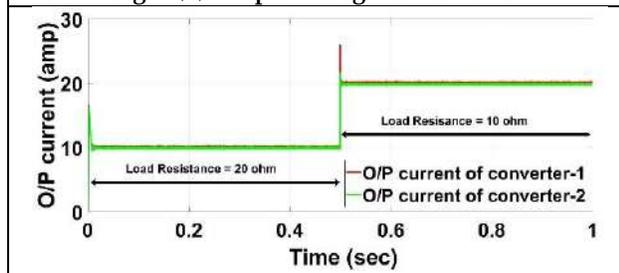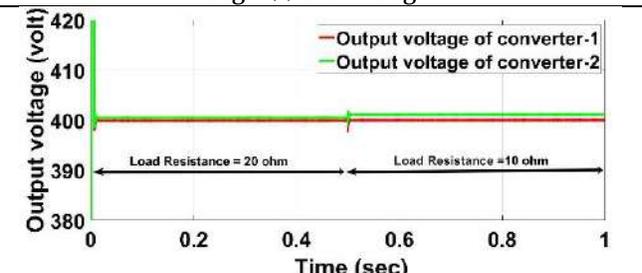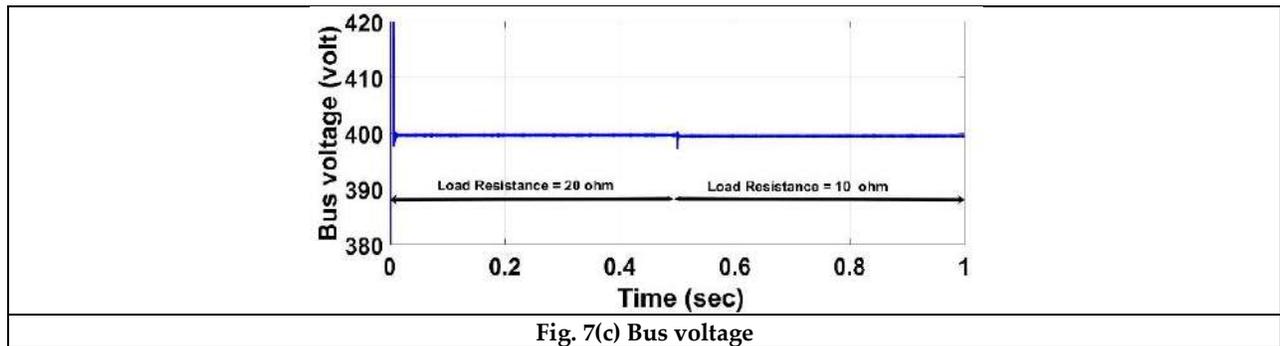
Fig. 7(c) Bus voltage

RESEARCH ARTICLE

Automatic Weed Prediction using Machine Learning

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ABSTRACT

Weeds are unwanted plants that compete with crops for essential resources, causing significant reductions in agricultural productivity. In recent years, breakthroughs in Agriculture using Artificial intelligence and machine learning techniques have the potential to transform and modernize how crops are grown, cared and even predict yield. This research proposes an innovative Image processing-based approach for automatic weed detection in agricultural fields. In this system, I will apply new methods to solve problems that farmers have been facing for hundreds of years. With the advancement in machine learning techniques and the availability of machine learning techniques, this work focuses on leveraging convolutional neural networks (CNNs) to make predictions in the native language on the identification of weeds and predict the yield of Crops. The performance of the proposed weed detection system is evaluated through rigorous testing on multiple real-world datasets, showcasing its ability to accurately distinguish between weed species and crops. This weed detection system offers numerous benefits for precision agriculture. By automatically identifying and mapping weed infestations, farmers can target herbicide applications more precisely, reducing chemical usage and potential environmental impacts. This paper details the promise of crop plant signaling for accurate and automated plant recognition in cropping systems. There is no doubt that this report is of great importance for scientists in related research fields to investigate the solutions for weed control in real-time.
Keywords: Automatic Weed Detection, Image Processing, Machine learning, Artificial Intelligence, Smart agriculture

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INTRODUCTION

Weed control is an important aspect of modern agriculture, as the presence of undesirable plants can significantly impact crop yields and reduce overall productivity. Until now, weed detection and removal has been a labor-intensive task that requires a lot of tasks time and effort from farmers. However, the integration of image processing and machine learning technologies has revolutionized weed detection, providing efficient and automated solutions for identifying and controlling weeds on farml and Image processing plays an important role in weed detection by allowing the extraction of relevant features and information from images captured in the field. Some of the common image-processing techniques used in weed detection are:

1. Image pre-processing: Techniques such as noise reduction, image enhancement, and color normalization improve the quality and clarity of the images and enable better analysis.
2. Segmentation: Image segmentation techniques help separate plants from the background and isolate weeds and crops for further analysis.
3. Feature extraction: Extracting relevant features from segmented images, such as texture, shape, and color, provides valuable data for machine learning algorithms.

The primary goal is distinguishing weeds from crops and other vegetation and providing accurate and efficient weed control solutions. Machine learning algorithms can be trained on large datasets of crop and weed images to learn the features and characteristics that distinguish one from the other. These algorithms can then be used to classify new crop images and detect the presence of weeds in a given field or area. Object recognition involves identifying the location and boundaries of objects in an image, while segmentation involves dividing an image into different regions based on its features. Classification involves categorizing objects based on their features. The benefits of machine learning in weed detection include higher accuracy, faster detection times, and lower costs. It can also help farmers reduce the use of herbicides, which can have negative impacts on the environment and human health. Overall, weed detection using machine learning is a promising area of research that has the potential to increase crop yields, reduce costs, and promote more sustainable farming practices.

Literature Survey
Weed detection systems have gained a lot of attention in recent years due to their potential in reducing the use of herbicides and improving crop yields. Here are some of the key papers on weed detection systems: According to the data above, there have been substantial improvements in weed detection using machine learning and image processing in recent years, but there are still some technological gaps that need to be filled by developing a proposed architecture for weed prediction.

Research Gap
From the above analysis, it has been clearly stated that Weed detection using machine learning and image processing has seen significant advancements in recent years, but there are still some technological gaps that need to be addressed. Here are a few areas where further development is needed:

1. **Data Collection:** One of the biggest challenges in developing machine learning algorithms for weed detection is collecting sufficient and diverse data. Collecting data from different locations, lighting conditions, and weed species can be time-consuming and expensive. Therefore, researchers need to come up with more efficient and cost-effective ways to collect data to train the models.
2. **Annotation:** Another challenge is the annotation of the images (with high and low accuracy) used in training the models. Therefore, researchers need to develop automated annotation methods that can accurately label the images without requiring human intervention.

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3. **Accurate detection of small weeds:** Most current weed detection algorithms are designed to detect large weeds, but accurately detecting small weed is still a challenge. Detecting small weeds is important because they can cause significant crop damage is left untreated.

Addressing these technological gaps, weed detection using machine learning and image processing will be essential for improving the accuracy and efficiency of weed control in agriculture.

Hypothesis

From above defined problem following proposed architecture is predicted for weed prediction system. This model represents weed prediction from the yield of any crop using Machine Learning techniques. The intention of layout this system is to aid farmers in noticing the weed growth at the earlier stage and assist them with appropriate steps to stop the growing of weeds in the field. In this system, the user has to take a photo of the weed with a crop through a mobile. Then after photo will dispatched to the system for further processing. In the rule base module, different information about height, width, size of weed, growth of weed, color of weed, etc. is stored in a database. In the training module, we train our weed images to identify weeds from the crop field. If once the system identifies accurate growth of weed from the crop then its details will be sent to the farmer. The system may even display the retrieved weed information in the form of audio. So, if any farmer is unable to read the details then he can pay attention to the audio and take necessary actions to protect the crops from weeds. Moreover, the system will offer professional recommendations to the needy farmer. Also, the farmer can ask any doubts or questions to experts in the frequently asked questions module. In response to such questions, an expert will share their perspectives and ideas for the farmers.

METHODOLOGY

Artificial Intelligence, Image Processing and Machine Learning:
Machine learning stands as a distinct field within both artificial intelligence (AI) and computer science. Its focus lies in employing datasets and algorithms to emulate the learning processes observed in humans, allowing for a gradual improvement in accuracy. Artificial intelligence, meanwhile, entails the replication of human intelligence processes through the utilization of machines, particularly computer systems. AI finds application in various domains, including expert systems, natural language processing, speech recognition, and machine vision.

How machine learning works:
1. A decision-making process: In general, machine learning is the algorithms used to make a prediction or classification of a specific crop. Based on some input data images are cropped, which it may be possible to not label classified classes, your trained algorithm creates an estimate of a structure in the data.
2. An error function: An error function is used to evaluate the prediction of the data set model. If there are known examples, an error function can make a comparison to evaluate the accuracy of the model.
3. A model optimization process: If the model can be better fitted to the data points in the training data set, the weights are adjusted to reduce the discrepancy between the known example and the trained model estimate. The algorithm repeats this "evaluation and optimization process" and updates the weights until an accuracy threshold is reached. [23]

Machine learning models fall into three primary categories.
1. Supervised Machine Learning
2. Unsupervised Machine Learning
3. Semi-Supervised Learning

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Convolutional Neural Network (CNN) in Machine Learning

Convolutional neural networks (CNN) are inspired by biological processes in all living things. CNN mimics the way the visual cortex processes light from the eyes and how is processed in the brain. CNN became really popular in machine learning after the popular Image Net competition of 2012. During that year's competition, a CNN called Alexnet was able to outperform all other models by a large margin. The competition consisted of training millions of images and predicting 1,000 different classes out of these images. With the success of Alexnet in the following years, all state-of-the-art models for image recognition or detection tasks were CNN-based. Today, some of these models have approached human performance in some tasks. The normal base task done with CNNs is the classification of digits. As you go deeper into the model it starts abstracting larger features related to the trained dataset images. CNNs algorithms are trained on the large dataset using a labeled image, where the CNNs algorithm learns to recognize all features and patterns associated with a specific crop or object. Once the model is trained, CNNs can be used to classify new images or extract the different features for use in different applications, such as crop detection or image segmentation.

Support Vector Machine (SVM) in Machine Learning

The support vector machine is a method of supervised learning system and is used for the classification and regression of linear and non-linear problems. The support vector machine is very popular with many because it achieves remarkable correctness with less computational power. It is mainly used for classification problems. There are three main categories of crucial learning algorithms: supervised, unsupervised, and reinforcement learning. A Support Vector Machine (SVM) serves as a discerning classifier, precisely characterized by its division through a classification of boundary. This division is different in classifying new instances, particularly within the context of labeled training data sets. When visualized in a two-dimensional space, the hyper plane takes the form of a line, effectively partitioning the plane into two distinct sections, with each class occupying one side. Throughout the classification process, the SVM algorithm strives to identify the optimal hyper plane within an N-dimensional space, facilitating the segregation of dataset points into discrete classes. Optimal boundaries for classification are determined by the SVM algorithm, effectively segmenting the dataset into various classes. These boundaries are strategically selected to optimize the margin, denoting the distance between the boundary and the nearest dataset points from each class. Of notable significance are the closest dataset points, commonly referred to as support vectors, which play a pivotal role in guiding the SVM algorithm's classification decisions.

Expected Outcomes

The expected output of the proposed research work is as follows

1. Design and develop a mobile-based system for weed detection amongst the crops.
2. Users of the proposed system will get the details about weed color, height, length, and location through which users can easily get an idea of the growth of the weed and take necessary steps against weed.
3. Users will get the proper information about weeds for particular crops in the form of audio, text, and images.

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Table 1. Literature Survey

Sr. No.	Title	Algorithm	Crop/Plant	Accuracy	Drawback
1.	IOT-based weed detection using image processing and CNN	CNN	Corn	85%	Only 250 images dataset using
2.	Mean and Range Color Features-Based Identification of Common Indian Leafy Vegetables	BPNN classifier	Leafy Vegetables	92%	It's only identified different leaves crop
3.	Using machine learning for weed identification and yield prediction of strawberries	YOLO, Faster R-CNN, and SSD Mobile	strawberries	80%	Can't detect small weeds & the image should be in high resolution.
4.	Weed Identification Using Deep Learning and Image Processing in Vegetable Plantation	Deep learning	Vegetable	95%	Only mechanical weeding can apply.
5.	Weed detection in soybean crops using Conv Nets	CNNs, SLIC Super pixel algorithm	Soybean crops,	72%	Only detect UAV images
6.	Early Weed Detection Using Image Processing and Machine Learning Techniques in an Australian Chilli Farm	RF, SVM, KNN	Australian Chilli Farm	96%, 94%, 63%	It works with only Australian Chilli plant.
7.	Real-Time weed detection using Machine Learning and Stereo-vision	CNN and ResNet-50 Algorithm	Onion Crop, Cucumber Crop	90%, 84.6%	It only detects weed rather than other properties.
8.	Crop and weed detection using image processing and deep learning techniques	RCNN	-	78.10&	not identifying the type of weeds
9.	Development of a weed detection system using machine learning and neural network algorithms	K-Nearest Neighbors, Random Forest	gardens and vegetable gardens	83.3%, 87.5 %	This system is suitable only for low resolution images of crop.
10.	A review of machine learning techniques for identifying weeds in corn	SVM, ANN	Corn	96.5% 83.2%	It's identify of weeds in corn seedlings field.
11.	Weed Identification Using Deep Learning and Image Processing in Vegetable Plantation	trained CenterNet	Vegetable Plantation	95.6%	Only for Vegetable Plant
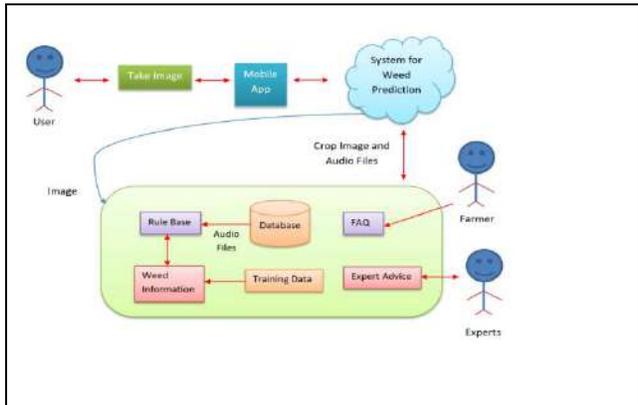
Fig.1. Proposed Architecture for weed prediction Model	**Fig.2 : Model of Artificial Intelligence**
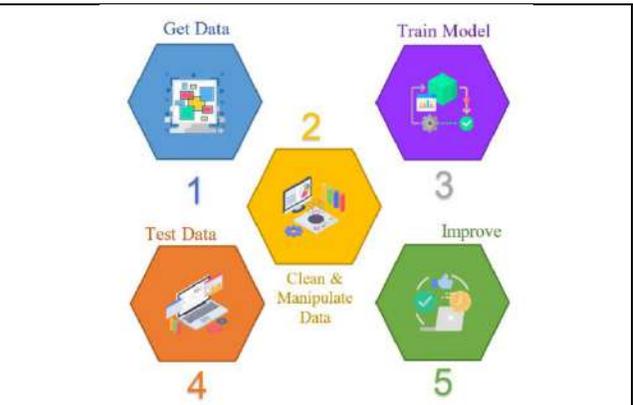
REVIEW ARTICLE

Next Generation Technologies for 5G and Beyond Networks: Overview, Recent Trends, and Challenges

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ABSTRACT

The global rollout of the fifth generation (5G) has recently started. 5G networks are designed to offer exponential increase in data rate, ultra-reliability, mass connection, and particular low-latency applications. However, 5G will not be able to meet all of the demands of the coming technological advances in 2030 and beyond. In comparison to 5G networks, sixth-generation (6G) cognitive radio (CR) networks are expected to introduce novel use cases and performance metrics, such as providing global coverage, cost efficiency, increased radio spectrum, energy intelligence, and safety. The growing global demand for ultra-high spectral efficiencies, data rates, speeds, and bandwidths in next-generation wireless networks motivate researchers to investigate the peak capabilities of massive MIMO (multiple input multiple output) and new technique filter bank multi carrier (FBMC). Lower out-of-band emissions is observed in FBMC technique compared to orthogonal frequency division multiplexing (OFDM), which is an essential requirement of upcoming next generation wireless systems. Arbitrarily larger SNR value obtained with higher number of BS antennas in Massive MIMO, which help to increase the data rate. This paper describes major enabling technologies for next-generation wireless communication, as well as its challenges.

Keywords: MIMO, OFDM, FBMC, 4G, 5G, 6G

INTRODUCTION

Analog voice communication capabilities were simple yet revolutionary in the first generation of cellular systems. In comparison to the previous generation, the second generation has digitalized voice to boost capacity, better battery life of device and quality of Service (QoS). At the time, the third generation enabled mobile Internet connectivity and data rates that were comparable to wired systems. Smart phones with massive storage and processing capabilities, as

well as high-definition cameras, together with social networks turning mobile users into content providers, have pushed fourth generation devices even further towards higher speeds. The fifth generation (5G) targets an exponential increase in data rate, device to device (D2D)communication, machine to machine (M2M) and the health sector [1],[2]. Fifth-generation cellular technology will replaced by sixth-generation wireless, or 6G in future. The bandwidth and latency of 6G [3],[4] networks will be significantly higher than 5G networks due to their ability to operate at higher frequencies. The 6G computational infrastructure, in conjunction with artificial intelligence (AI), will be able to decide where computing should take place, including decisions regarding data storage, processing, and sharing. It is important to keep in consideration that 6G is still a developing technology and some companies are making investments in the sixth-generation.

Key Enabling Technologies for 5G

Enhanced mobile broadband, massive machine-type communication, ultra-reliable and low latency communication have been identified as the requirement to be supported by the fifth generation. 5G networks will require a major paradigm shift to satisfy the increasing demand for higher data rates, lower network latencies, better energy efficiency, and reliable ubiquitous connectivity. The major technological breakthrough requires to bring 5G into practice are new waveforms, Massive MIMO, new radio access techniques, millimeter wave, the internet of things etc. Massive MIMO uses a higher number of antennas to achieve massive spatial multiplexing benefits, resulting in a multi-fold increase in cellular network capacity. Fig. 1 shows essential techniques specified to achieve the 5G specification into reality [5],[6],[7]. The network speed of 5G will be around 20 times faster than that of 4G. It will provide up to 10 Gbps download and 1 Gbps upload speeds. This will provide seamless data connectivity and permit real-time data sharing across billions of connected devices. This will revolutionize the agriculture industry and positively affect customers, farmers, agribusiness firms, and others. Due to the high bandwidth of 5G services, 5G powered drones will provide high-quality visual data that can detect pests and diseases and apply pesticides to the target areas based on real-time data. 5G technology will revolutionize the health sector with higher speed, low latency and improved data accuracy. It will make it possible for healthcare professionals to easily access and accurately analyze patient data. Particularly in rural places, 5G will make remote learning more interactive. With IoT devices in mind, 5G connects a greater density of devices at faster rates, almost eliminating lag. Therefore, 5G delivers a fantastic user experience regardless of the application, device you use.

Beyond 5G

India, like the rest of the globe, is thinking about the next generation of telecom technologies and the transformations they are expected to bring. Since wireless communication technology requires many resources, more spectrum is required to handle higher data rates. This is especially true as the technology advances. The utilization of spectrum is expanding to higher frequency bands as mobile communication technologies advance to new generations. While 5G was the first to employ mm Wave frequency bands, 6G is anticipated to investigate even higher frequency bands, such as (sub-) THz. Although low- and mid-band frequencies are crucial for mobile communication systems to attain widespread coverage. The mm Wave band has greater technical challenges compared to low- and mid-bands because of more severe radio propagation characteristics. By using Massive MIMO networks and sub-THz transmission with maximum bandwidth, spectral efficiency can be improved. Table 1 and Table 2 indicate the critical parameters such as bandwidth requirements, data rates, and features for each generation. Figure 2 depicts technological progress from 2010 to 2030.

Cognitive Radio

Currently, the information and communication business is experiencing global challenges such as the creation of new services with improved quality of service (QoS).There appears to be a fear that an impending spectrum crisis may arise, in which the increased demand from smart mobile devices would soon exceed wireless capacity. The challenge is the lack of additional spectrum in cellular data carriers. The CR concept was proposed to evaluate the efficiency of the spectrum consumption problem. Cognitive Radio, a technology optimizes the utilization of radio frequency spectrum, which is currently facing increasing demand but limited availability. Recent times have

witnessed a surge in wireless applications, predominantly driven by mobile users. However, the majority of the radio spectrum is already allocated, leaving only a small portion available for licensing to new wireless services. The Spectrum Policy Task Force (SPTF) within the Federal Communications Commission (FCC) conducted research on frequency bands and made some noteworthy findings. They observed that in specific geographical areas and timeframes, several frequency bands experience low occupancy. Conversely, certain frequency bands are heavily utilized by licensed systems. To illustrate, in the United States [8], [9],[10] cellular network spectrum bands are extensively used during regular working hours but remain largely unused between midnight to early morning.

In the current spectrum licensing approach, the allocation of radio frequencies operates under a command and control model. Unfortunately, this model results in suboptimal utilization of the available radio spectrum. Under this system, if a licensed user doesn't fully utilize their allocated spectrum, it remains inaccessible to unlicensed users and their applications [11]. Consequently, only those with dedicated spectrum licenses can employ the radio spectrum, and these licenses do not allow for adaptive adjustments based on varying environmental conditions. For instance, if a wireless system is using a specific frequency band extensively, it cannot switch to another less congested band, even when that option might be more efficient. Under the current spectrum licensing system, when a license is granted to a particular entity, it comes with specific conditions pertaining to parameters such as power, space, frequency, the intended purpose, and the duration of the license. What is important to note is that in this scheme, licensees are typically not allowed to modify the intended use or transfer these rights to another entity. This rigid framework results in a restricted utilization of the frequency spectrum, leading to its underutilization. This situation gives rise to what are known as spectrum holes or spectrum opportunities. Spectrum holes refer to frequency bands that have been officially allocated to licensed users but remain underutilized at certain times and in specific locations as shown in fig.3. Interestingly, these frequency bands could potentially be used by unlicensed users [12].

To avoid this limitation and to increase utilization of available spectrum, modification in spectrum licensing scheme is necessary. This will also increase the system efficiency. This become possible if unlicensed users can also access the available spectrum with certain restrictions. This is possible only if access of available radio spectrum is flexible. Currently, a particular wireless system can access only dedicated radio spectrum which is assigned to that system. It is not flexible. The improved flexibility by the spectrum licensing scheme will not be used by them. With this concept, Cognitive Radio is introduced. Cognitive Radio improves the performance of wireless transmission system with dynamic access of radio spectrum by users. In addition, Optimum utilization of frequency spectrum is possible with this concept of Cognitive Radio. With the help of spectrum sensing, cognitive users can identify the current activity on target spectrum if it is in use by licensed user or not. After spectrum sensing, the information regarding the spectrum is passed to Spectrum Management. Here decisions on spectrum access are made based on spectrum opportunities. During transmission of cognitive users if there is any change in that particular spectrum, the frequency band of cognitive user is changed by next stage of Spectrum Mobility. The main functions of cognitive radio are given below.

Spectrum Sensing

Spectrum Sensing serves the purpose of assessing the status of a specific frequency range, primarily to determine the activity of licensed users. It involves regular monitoring of the desired frequency band. In this process, Cognitive Radio systems [13] ,[14] play a pivotal role in identifying unused spectrum, known as spectrum holes. Furthermore, these cognitive radios also determine how to access this spectrum, considering factors like transmission power and access duration, all without causing interference to licensed users. Spectrum sensing can be categorized into two approaches: centralized and distributed. In centralized spectrum sensing, a sensing controller (like an access point or base station) is responsible for monitoring the target frequency band. The data collected is then shared with other nodes in the system. Centralized sensing simplifies the involvement of user terminals but may pose challenges related to location diversity. For instance, the centralized sensing controller might not effectively reach an unlicensed user at the periphery of the coverage area. In contrast, distributed spectrum sensing [15] involves unlicensed users autonomously conducting spectrum sensing. The data they collect can be used individually by cognitive radios which is called non-cooperative method or shared with other users which is known as cooperative sensing.

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Cooperative sensing add over head in terms of communication and processing but generally results in more reliable spectrum sensing compared to non-cooperative methods.

Spectrum Analysis

Spectrum management primarily revolves around two key aspects: spectrum analysis and spectrum access optimization. In spectrum analysis, valuable insights are gleaned from spectrum sensing data. This includes information about spectrum holes, such as when they are available, estimations of potential interference, and the likelihood of collisions with licensed users due to sensing errors. This analysis forms the foundation for making informed decisions regarding spectrum utilization. The process of gaining access to the spectrum involves making decisions that improve system performance while achieving desired outcomes, such as maximizing the output of unlicensed users. This decision-making encompasses various parameters like bandwidth, modulation mode, geographical location, time duration, and frequency assignment. All of these choices are made with the overarching goal of ensuring that interference to licensed users remains below specified target levels.

Spectrum Access

Once a decision is reached through spectrum analysis, unlicensed users can access spectrum holes. This access is facilitated by a cognitive Medium Access Control (MAC) protocol, which is designed to prevent collisions both among unlicensed users and with licensed users. To ensure smooth coordination and synchronization of transmissions, cognitive radio transmitters communicate with cognitive radio receivers. This coordination is crucial for effective data transmission. The choice of MAC protocol can be based on either random access (e.g., ALOHA, CSMA/CA) or fixed allocation (e.g., FDMA, TDMA, CDMA) principles. These MAC protocols serve as the foundation for how cognitive radios access and utilize the available spectrum, ensuring efficient and interference-free operation.

Spectrum Mobility

Spectrum Mobility is the term used to describe the ability of cognitive radio users to adapt and switch their operating frequency bands as needed. When a licensed user begins using a radio channel that is currently being used by an unlicensed user, the unlicensed user must perform what is known as a spectrum handoff. During a spectrum handoff, several protocol parameters across different layers of the protocol stack must be adjusted to align with the new operating frequency band. It is crucial to ensure that the unlicensed user's data transmission seamlessly continues in this new spectrum band. In essence, spectrum handoff is the process of smoothly transitioning to a different frequency band to accommodate changing spectrum usage conditions.

Components of Cognitive Radio

As per changing environment, there are mainly four functions performed by cognitive radio to adapt the transmission parameters. These four functions of cognitive radio are shown in   fig.4.

Decision Making

In the stage of Decision Making, the information about spectrum Occupancy is used to take the decision about spectrum access. The behavior of unlicensed user is also taken into consideration. Their behavior can be competitive or cooperative. Various techniques are available to get the optimal solution. Optimization theory is one of the techniques. Optimization Theory is suitable if there is single entity with a single objective. Although, Game theory is applicable if there are multiple entities with its own objective. Stochastic optimization is suitable for decision making for random systems.

Wireless Transmitter/Receiver

Signal transmission and reception is the main responsibility of Transmitter/Receiver. In addition, it is also used for the purpose of Spectrum Sensing. It checks the frequency spectrum activity. It changes its parameters dynamically if required as per higher layer protocol instructions

Spectrum Analyzer

The job of Spectrum Analyzer is to find the spectrum vacancy for unlicensed users by checking the presence of a signal by a licensed user. Spectrum Analyzer also ensures that due to spectrum usage by unlicensed user, the licensed user transmission is not affected. Various signal processing techniques are available to get the information about spectrum occupancy.

Learning / Knowledge Extraction

licensed users use Learning and knowledge extraction for understanding the spectrum utilization. To optimize and adapt the transmission parameters, a base is built and maintained which contains spectrum access environment so that the desired objective under various constraints is achieved. Various Machine-learning algorithms are used for this purpose.

OFDM and FBMC

The 4G mobile communication system employs OFDM modulation technology. Due to higher out of band emissions, OFDM is unlikely to be considered for the next-generation wireless communication systems. In OFDM, rectangular shape filter used which is replaced by a new waveform in FBMC technique. OFDM filters the entire band while FBMC, which is the generalization of OFDM, filters each subcarrier independently. FBMC is proposed as an alternative to OFDM, which does not use a cyclic prefix (CP), hence, it is more spectrally efficient than OFDM. Power spectral density comparisons of OFDM and FBMC that can be used in the CR network and future generation wireless systems are carried out. The difference between OFDM and FBMC lies in the choice of the transmitter and receiver prototype filters. OFDM uses rectangular filters at the transmitter and receiver end while FBMC uses non-rectangular filters, so different characteristics could be obtained according to the filters used. The choice of pulse width parameter in transmitter and receiver prototype filters are different in OFDM and FBMC techniques. In comparison among FBMC using PHYDYAS, conventional FBMC using a Hermite, and OFDM with rectangular, FBMC with PHYDYAS has shown the best performance as depicted in Fig. 5. Comparatively 50 dB lower out of band emissions are noticed with FBMC using PHYDYAS than CP-OFDM.

Massive MIMO

5G was the first to use millimeter Wave frequency bands, while 6G is expected to study even higher frequency bands, such as (sub-) THz. THz improves the potential and high frequency problems in CR communication systems. THz communication has a few basic characteristics such as high frequency causing high path loss and broadly available bandwidth to support high data rate. Interferences are reduced using highly directed narrow bandwidth antennas. Massive MIMO with a huge number of BS antennas will allow for arbitrarily high SNR values, which will be particularly useful in 6G communication networks. Massive MIMO extends the MIMO system by including a significantly greater number of antennas on the base station. The "massive" number of antennas help focus energy, which brings drastic improvements in throughput and efficiency. The Massive MIMO model is described as shown in Fig. 6, where BS contains M antennas that serve K single antenna users where $M \gg K$[16],[17].Tens of mobile terminals (MTs) are being served simultaneously by the base station (BS), which has a huge number of antenna elements about hundreds or more. By coherently combining signals at BS antennas, uncorrelated noise and the multiuser interference effect can be reduced[18],[19], [20]. In Massive MIMO, the number of BS antennas will enable the achievement of arbitrarily high SNR values as shown in fig.7. Massive MIMO technology will therefore be beneficial in 6G communication networks.

CONCLUSION

There are several large cities in developed nations that are using 5G network connection, and it is expanding world wide. However, the needs of users and industries for the CR network in 2030 are not being met by 5G. A high capacity and low latency 6G wireless network is anticipated to support client applications and improve communication latency. FBMC is more suitable in next-generation wireless communications compared to OFDM

because it will achieve lower out of band emission, which is one of the requirements of next generation wireless communications. In a Massive MIMO, adding more BS antennas will help to raise the average SNR value, which will help to improve spectral efficiency.

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Table1: bandwidth of each generation

Sr. No.	Generation	Bandwidth
1	2G	200 KHz
2	3G	5 MHz
3	4G	20 MHz
4	5G	100 MHz
5	6G	500 MHz-1GHz

Table2: Evolution of wireless technologies

Sr. No.	Generation	Commencement year	Data rates	Features
1	1G	1980	2.4kbps	Voice service
2	2G	1992	200kbps	Voice service, Data service
3	3G	2000	30Mbps	Voice service, Data service, Video call
4	4G	2010	1Gbps	Voice service, Data service, Video call, DVB, HD TV
5	5G	2020	20Gbps	Voice service, Data service, Video call, DVB, HD TV, AR/VR, Smart City
6	6G	2030(Expected)	1Tbps	Voice service, Data service, Video call, DVB, HD TV, AR/VR/XR, IoE, AI-enabled Smart City, Edge AI, Blockchain

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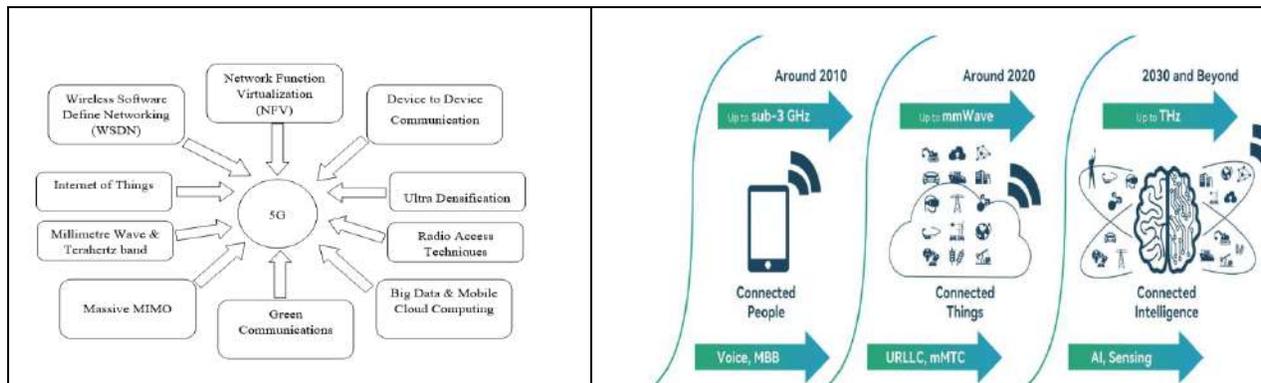
Fig. 1: Key-Enabling Technologies

Fig. 2: Mobile communication beyond 2030
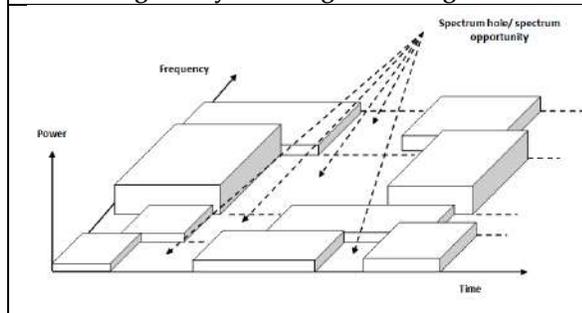
Fig. 3: Spectrum Hole (or Spectrum Opportunity)
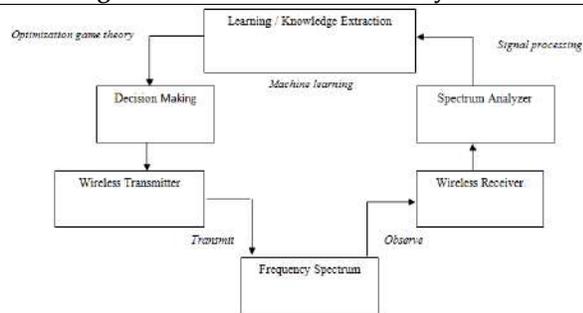
Fig. 4: Components in a Cognitive Radio node.
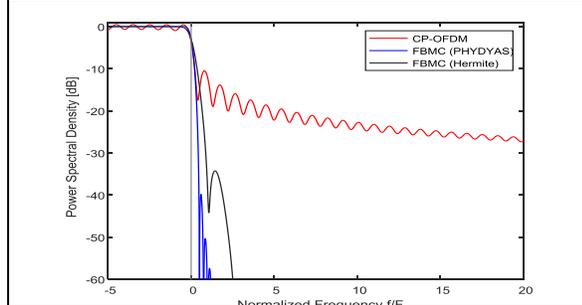
Fig. 5: Comparison of the PSD for FBMC and OFDM
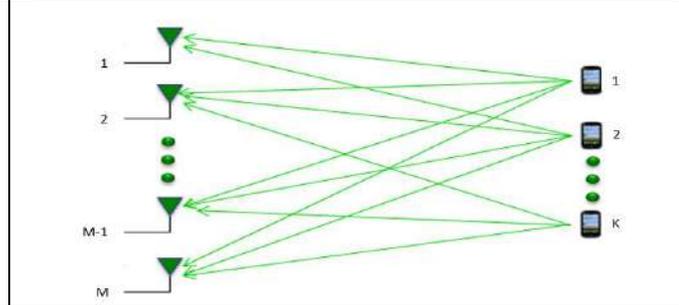
Fig. 6: Massive MIMO architecture
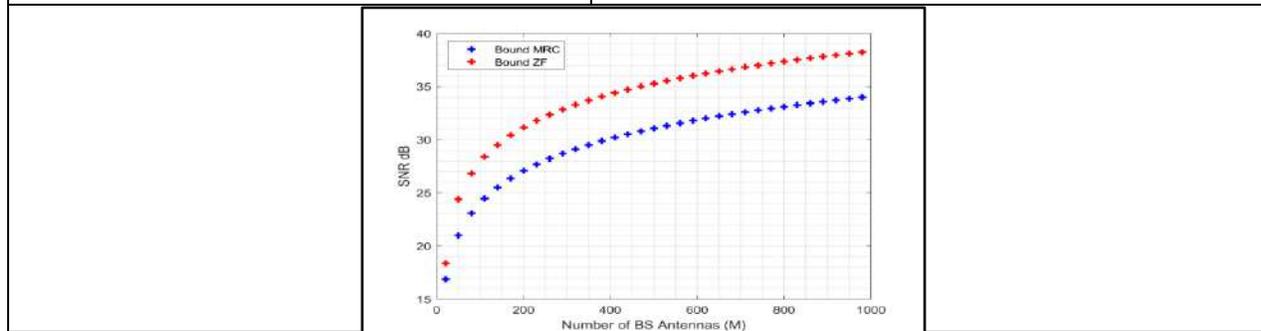
Fig. 7: SNR performance with M number of BS antennas for K = 10 users

REVIEW ARTICLE

A Review of MicroStructural Evolution in Steel: from Cementite to Spheroids

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ABSTRACT

This review paper delves into the spheroidization processes employed in steel treatment to achieve softening of the initial structure for improved formability and machine ability. Various methods are explored, with subcritical and inter critical annealing being the most common, either in a single cycle or multiple treatment cycles. Crucially, these treatments are executed at temperatures slightly below Ac1 or above it. Spheroidization is attained through the cooperative growth of ferrite and cementite in laminar fashion from austenitized steel or by inducing a divorced eutectoid transformation, which involves non-cooperative movement of ferrite and cementite resulting in a divorced eutectoid structure. Deformation itself enhances spheroidization, and when coupled with appropriate annealing treatment, it leads to reduced annealing times and increased levels of spheroidization. In hypereutectoid steels, the divorced eutectoid transformation (DET) takes precedence over the pearlite reaction at lower austenitizing temperatures and slower cooling rates. Finally, the initial structures of steel play a pivotal role in all spheroidizing processes. This review provides comprehensive insights into the intricate processes, mechanisms and microstructures involved in achieving spheroidization in steel treatment.

Keywords: Heat treatment, Spheroidization annealing, Pearlite, Cementite, Eutectoid temperature, SA/V ratio, D.E.T., Hypereutectoid steel, Effects of Alloying Element on Spheroidization

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INTRODUCTION

Heat treatment of metals, dating back to antiquity, involves controlled heating and cooling to enhance physical and mechanical properties. Annealing, a vital process, entails heating, soaking, and slow cooling, reducing stresses and refining the microstructure for improved machinability and ductility. Pearlite steel's alternating ferrite-cementite layers pose machining challenges, including tool wear, irregular surface finish, erratic chip formation, and tool failure due to inherent brittleness. Spheroidization annealing transforms steel's microstructure into globular cementite in a ferrite matrix, enhancing machinability, ductility, and tool life by reducing built-up edges during machining, ensuring smoother finishes.

PEARLITE STEEL

Austenite is an interstitial solid solution of 0.8% carbon and F.C.C. gamma iron. After eutectoid reaction & phase transformation austenite is to change to alpha ferrite. Ferrite having B.C.C. crystal structure has less vacant space, however dissolves very little carbon. Change in microstructure cannot happened until carbon atoms come out of solution. Therefore, the first step is the precipitation of carbon atoms to form plates of cementite (iron carbide). Immediate adjacent side of cementite plate, iron is depleted of carbon and the atoms may now rearrange themselves to form B.C.C. ferrite. Thin layers of ferrite are formed on each side of the cementite plate. The process continues by the formation of alternate layer of ferrite and cementite, give fine fingerprint mixture known as pearlite.[1-2]

Spheroidization Annealing

Spheroidizing annealing is a heat treatment process used for steel to change its microstructure and make it easier to work with. This is done by heating the steel to temperatures just below or above the Ac1 temperature (the eutectoid temperature) and then slowly cooling it down. Before this process, the steel's microstructure can be ferrite-pearlite (for low-carbon steels), pearlite (for medium-carbon steels), or cementite-pearlite (for high-carbon steels).[2]
There are three main methods for achieving spheroidization

1. Subcritical Annealing: This method involves holding the steel at a temperature just below the Ac1 point for an extended period. It is most effective for low-carbon steels (hypoeutectoid) and helps transform the microstructure into a more desirable form.
2. Inter-critical Annealing: In this approach, the steel is heated to a temperature just above the Ac1 point and then cooled very slowly in a furnace or kept at a temperature just below Ac1. This method is often used for high-carbon steels (hypereutectoid) and achieves the desired structural changes with greater certainty.
3. Cyclic Annealing: Cyclic annealing involves alternating between temperatures just above and below the Ac1 point. This method is particularly useful for accelerating the transformation of cementite (a hard and brittle phase) into a globular form within the steel's structure. By increasing the temperature above Ac1, the cementite dissolves, and upon subsequent cooling below Ac1, it re-forms in a more desirable globular shape. This globular cementite within the ferritic matrix is the preferred structure because it has the lowest energy content in the iron-carbon system. The rate of carbon diffusion during this process depends on factors such as temperature, time, and the presence and amount of alloying elements in the steel.

Subcritical annealing shown in Fig. (2a) is the most efficient process for hypoeutectoid steels, while in hypereutectoid steels, the morphological change is achieved with greater security through inter-critical treatment, or cyclical treatment shown in Fig.(2b) and (2c).[3] Cyclic process shown in Fig. (2c) is used to speed up the transformation of cementite lamellas (thin layers of a specific compound in steel) into a rounded or globular shape. To make this happen, we raise the temperature above a critical point called Ac1. This higher temperature helps dissolve the cementite lamellas. Then, when we cool the material back down below Ac1, the dissolution process is interrupted, causing the lamellas to break into smaller pieces. These broken pieces, which have lower resistance and surface energy, come together more easily and quickly. The reason behind this is that they tend to coalesce or clump together within the ferrite matrix (the surrounding material). This entire process is driven by the movement or diffusion of

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carbon atoms. When the cementite particles take on a globular shape within the ferrite material, it results in the structure with the lowest energy content among all possible structures in the iron-carbon system.The speed and success of this transformation depend on factors like temperature, time, and the type number and amount of alloying elements present in the steel being used.[4]

Surface Area / Volume (Sa/V) Ratio of Globular Cementite

When cementite particles are spheroidized, the lamellar structure breaks down into smaller, rounded particles with increased surface area due to the spherical shape. The SA/V ratio increases because the surface area of the particles increases while their volume remains relatively constant. This altered microstructure has favorable effects on mechanical properties as it reduces stress concentration points and enhances overall material performance. The specific SA/V ratio of globular cementite after spheroidization will depend on factors such as the initial microstructure, spheroidization temperature, duration of treatment, and the composition of the alloy. Generally, a higher SA/V ratio indicates a finer and more uniform microstructure, which can lead to improved mechanical properties [2].

Divorced Eutectoid Transformation (DET)

Normally, when certain materials go through a transformation called the eutectoid reaction, they form a structure called lamellar pearlite, which isn't always ideal. But with the right conditions (specifically, the right parameters), we can make sure that this eutectoid reaction leads to a different structure called spheroidized cementite within a material called austenite. This process is known as the "Divorced Eutectoid Transformation" or DET. During DET, the cementite particles change into a spherical (or divorced) shape directly within the austenite material. These particles grow in a particular way, moving along the boundary between austenite and ferrite, two different phases of the material. Here's how the process works step by step:

1. First, the material is heated to a high temperature where it consists of only austenite and cementite.
2. Then, it's slowly cooled down. This controlled cooling is crucial because it allows the material to undergo eutectoid decomposition, but instead of forming the undesirable lamellar pearlite structure, it creates a mixture of spheroidized cementite within the austenite.
3. During this transformation, the proeutectoid cementite particles (the ones that were there before the transformation) grow and absorb excess carbon as the austenite turns into ferrite.
4. This results in a final microstructure where the cementite particles are spherical and embedded within the ferrite, making the material stronger and more suitable for certain applications.

Importantly, this transformation only happens at temperatures just below a specific point called Ac1, and at slightly lower temperatures, it changes into the lamellar pearlite structure instead. So, controlling the temperature is crucial to achieving the desired spheroidal cementite structure.[5] To quickly achieve the spheroidization of cementite, the key is to change how the transition from austenite to pearlite occurs. This involves controlling the thermodynamics (how energy is distributed) and kinetics (how fast reactions happen) of the phase transition. In this case, we want to shift from the traditional lamellar mechanism to a mechanism known as the Divorced Eutectoid Transformation (DET). The DET process involves carbides settling around the original granular cementite and transforming into spherical shapes. So, the formation of spherical cementite happens in two main stages:

1. **Dissolution and Granulation:** This occurs during the process of austenitization, where the original cementite begins to dissolve and granulate within the material.
2. **Spheroidization and Growth:** After the material has been supercooled (cooled below its usual transformation temperature), the remaining austenite undergoes spheroidization and growth through the DET process. This leads to the formation of spherical cementite within the material.

This process has been extensively studied and documented in the literature for eutectoid transformations in steels. It results in the transformation of the material into a mixture of spheroidal cementite and ferrite, with the

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transformation front progressing through the material in a specific manner, as illustrated in Figure 4. This transformation typically starts from a normalized structure, which is an initial condition used to prepare the material for these changes.[6]

Spheroidized Hypereutectoid Steels

There are two ways to change the structure of hypereutectoid steels to make them more useful:

1. Method 1: Heat the steel just below a specific temperature (called Ac1), which causes the existing structure (pearlite) to change into round shapes (spheroids). This change happens because the energy at the interfaces between different parts of the steel decreases. This method is called "spheroidizing."
2. Method 2: Heat the steel to a high temperature where it turns into a different structure called austenite, but some parts (cementite) remain as round particles. Then, cool the steel down through another specific temperature (eutectoid), which causes the remaining particles to grow, absorbing extra carbon. As this transformation happens, you end up with big round cementite particles in a matrix of a different material called alpha-ferrite. This final product is called "divorced eutectoid" because the phases no longer grow together.

In hypereutectoid steels, the second method is usually used. This method involves heating the steel above the Ac1 temperature to change the structure and partially dissolve the cementite particles at the grain boundaries. The end result is a structure with two different sizes of cementite particles, with the larger ones mainly located at the grain boundaries of the austenite. It's also worth mentioning that if you heat the steel above Ac1 but below another temperature called Acm, you get a different result. In this case, the cementite doesn't completely dissolve, and you end up with fine cementite particles in the austenite. These particles can then transform into a mixture of ferrite and cementite through two different reactions: one called the pearlitic reaction and the other called the divorced eutectoid transformation reaction (DET). The key difference between these two reactions is that pearlitic reaction leads to the growth of a combined structure of ferrite and cementite, while DET doesn't combine them but results in a densely distributed pattern of cementite particles in the austenite. This gives a soft structure with round cementite particles in a ferritic matrix. [8-12]

Influence of Deformation on the Spheroidization

When you subject a steel material to deformation, whether it's done at low or high temperatures, it actually makes the material stronger and changes the way certain structures within the steel look. Specifically, it makes something called cementite become more rounded. The more you deform the steel, the more rounded the cementite becomes when you later heat it up (anneal it), and this means you don't need to heat it for as long as usual. Research [13] found that when they deformed low-alloy, medium carbon steels to a certain extent (a strain of at least 0.3), they could end up with steel that had almost completely rounded structures when they annealed it. This rounding was so thorough that over 90 percent of the structures became rounded, even if they originally looked like something called pearlite, which has a different shape.

1. Deformation: Deformation, whether done at low or high temperatures (cold or hot), helps to speed up the spheroidization process of cementite in the steel. The more deformation is applied, the more effective the spheroidization becomes after annealing, which means the required time for this process is shorter compared to the traditional method.
2. Effect of Deformation-Induced Carbides (DIC): The presence of deformation-induced carbides (DIC) significantly affects spheroidization. Carbides that form at grain boundaries and in areas where deformation occurs help the spheroidization process. However, if carbides form networks due to deformation, it can hinder the process. DIC serves as starting points for new carbide particles, which transform into ferrite, leading to the formation of a ferrite matrix and spheroidized carbides instead of the usual lamellar pearlite.
3. Cold Deformation: Cold deformation done prior to the spheroidization process notably accelerates the rate at which pearlite-ferrite microstructures transform into spheroids. In cases where the steel hasn't been deformed beforehand, the process of spheroidization is still effective because the austenite formed during heating directly

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produces ferrite and spheroidal cementite particles, making the process even faster than when cold deformation is involved [14].

EFFECTS OF STARTING STRUCTURES ON SPHEROIDIZATION
Spheroidization of cementite in steel is influenced by various factors, such as time, temperature, and the initial microstructure of the steel.

1. Initial Microstructure: The starting condition of the steel matters. Spheroidization can occur when starting from different steel structures, including laminar pearlite (resulting from eutectoid annealing), martensite, coarse pearlite, fine pearlite, and bainite. Each type of initial structure requires a different treatment process.
2. Effect of Initial Microstructure: According to research by Arai et al., the fastest spheroidization occurs when starting from the most unstable initial microstructure, primarily martensite. The rate of spheroidization in these unstable microstructures depends on how quickly carbon atoms move within the microstructure and come together.
3. Spheroidization in Pearlite: When the initial structure is pearlite, spheroidization happens through the coagulation (coming together) of the cementite lamellae (thin layers). This process has two stages. In the first stage, the cementite lamellae change shape to become knuckle-like. In the second stage, they form globules at their ends, and due to surface energy considerations, these globules eventually turn into rounded spheroids, known as spheroidal cementite.
4. Diffusion Control: The speed at which spheroidization occurs in both stages is controlled by the diffusion of carbon atoms within the microstructure. Essentially, the carbon atoms need to move to specific locations for the cementite transformation to take place.
5. Lamellar Cementite Thickness: The thickness of the initial cementite lamellae affects the energy required for the spheroidization process. Thicker lamellae require more energy to transform into spheroids. [15-19]

Effects of Alloying Element on Spheroidization
Alloying elements can have different effects on spheroidization. The addition of chromium (Cr) refines the particle size of spheroidized cementite, making it smaller. On the other hand, the addition of certain alloying elements like titanium (Ti), vanadium (V), niobium (Nb), and others, which are strong carbide formers, can slow down the spheroidization process by reducing the diffusion of carbon in the ferrite phase of the steel. [20-28]

Chromium Effect on Spheroidization
Chromium plays a significant role in the spheroidization process of steel. The addition of chromium extends the range of temperature and time during the austenitization phase, facilitating the Diffusional Exchange Transformation (DET) reaction upon cooling. In steels with low chromium content or no chromium at all, promoting the DET reaction becomes challenging. However, by carefully controlling the spacing of cementite particles during the austenitizing treatment and adjusting the cooling rate, it's possible to overcome this challenge and achieve a sufficiently spheroidized structure in low-chromium steels. A study by N.V. Luzginova et al. [30] explored the impact of chromium on the spheroidization process in medium carbon steels. They examined three types of steel samples: 0.5% chromium, 1.5% chromium, and 2.5% chromium. Specific process parameters, including time and temperature, were selected to encourage the Diffusional Exchange Transformation (DET) reaction. The results indicated that the addition of chromium allowed for the formation of a spheroidized structure at higher austenitization temperatures and longer annealing times compared to low-chromium steel. Additionally, the DET reaction occurred at a lower subcooling temperature compared to the pearlitic reaction. Micro structural analyses revealed distinct differences among the steel samples. Steel with 1.5% chromium and 2.5% chromium content exhibited well-spheroidized structures, as depicted in Figures 6 (c) and (d). In contrast, the steel with 0.5% chromium content displayed incomplete spheroidization of the cementite, as shown in Figure 6 (b). This incomplete spheroidization was evident in non-spheroidized areas, such as the one highlighted within the red circle.[31]

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Aluminum Effect on Spheroidization

In their study, H.L. Yi and colleagues (Yi et al., [32]) delved into the process of expediting spheroidization in eutectoid steel through the addition of aluminum. Their investigation unveiled a two-stage definition for the spheroidization process, involving the breaking of cementite lamellae and the thickening of cementite particles. The introduction of aluminum was found to elevate the spheroidization temperature by raising the initial austenite temperature, which in turn refined the interlaminar spacing. To elucidate, the authors initially established the correlation between annealing temperature, interlaminar spacing, and the two stages of spheroidization. Subsequently, they elucidated the mechanism behind how aluminum accelerates spheroidization. Aluminum functions as a potent ferrite stabilizer, augmenting the eutectoid temperature during the cooling phase. Consequently, this refinement occurs due to increased subcooling during the eutectoid transformation, which hampers lamellar growth through the overall diffusion of aluminum into the cementite. This refined interlaminar spacing expedites the disintegration of cementite flakes during the initial stage of spheroidization but is less effective in thickening cementite particles, a process solely reliant on diffusion. Moreover, aluminum enhances the initial austenite temperature during heating, thus expanding the potential spheroidization annealing temperature. The heightened heat treatment temperature plays a pivotal role in spheroidization acceleration by enhancing the diffusivity of the alloying elements and exerts a significant influence on the thickening of cementite particles during the second stage of spheroidization.[18]

CONCLUSION

After conducting a thorough review of the processes involved in spheroidization treatment of steels, along with an examination of mechanisms and microstructure changes, the following key findings and conclusions have been reached

1. Improved Cold Forming and Machinability: Spheroidization treatment enhances the cold forming and machinability characteristics of steels. It achieves a spheroidized structure comprising cementite carbides within a ferrite matrix. This structure can be achieved through two primary methods: cooperative growth of ferrite and cementite in laminar form from austenite or by inducing a divorced eutectoid transformation (DET). However, DET, while faster, does not optimize the distribution of proeutectoid cementite particles in the austenite.
2. Spheroidization Mechanisms: Several models have been proposed to explain the spheroidization mechanism of pearlite. These models typically focus on the extent of lamella rupture. However, this scope is limited as it does not consider the thickening of cementite particles observed in soft annealing treatments.
3. Microstructure Influence: The initial microstructure plays a significant role in the spheroidization process. Various studies have been conducted using different starting structures, often achieved through continuous cooling from a specific austenitization temperature. It's important to note that continuous cooling leads to phase transformations occurring over a temperature range determined by the cooling rate. As a result, micro structural characteristics related to temperature, such as inter laminar spacing and cementite thickness or length, vary and are not homogeneous.
4. Deformation Effects: Deformation accelerates spheroidization kinetics and increases the degree of spheroidization. Several phenomena occurring during spheroidization treatment contribute to matrix softening. Combining deformation with annealing treatments results in shorter annealing times and higher levels of spheroidization.
5. Hypereutectoid Steels: In the spheroidization processes of hypereutectoid steels, the divorced eutectoid transformation reaction (DET) dominates over the pearlite reaction at lower austenitizing temperatures and slower cooling rates. This finding highlights the importance of temperature and cooling rate control in achieving the desired spheroidized structure in hypereutectoid steels.

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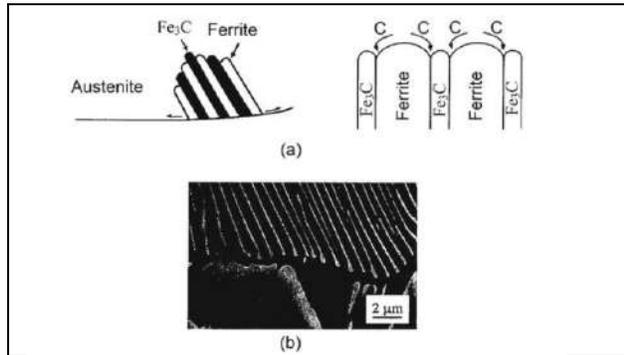
Fig. 1. Transformation of the eutectoid austenite into pearlite: (a)scheme, (b)micrograph [1]
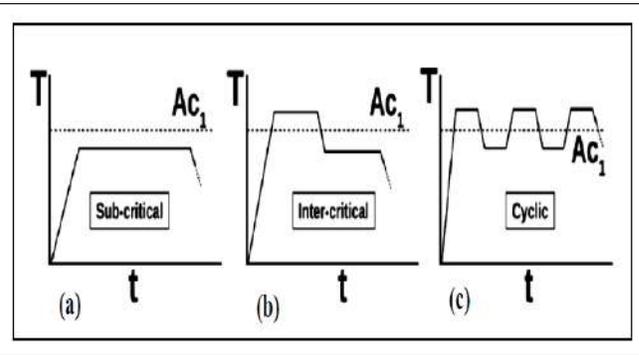
Fig. 2. Temperature–time regimes at spheroidizing annealing. (Ac1 represents the eutectoid temperature)
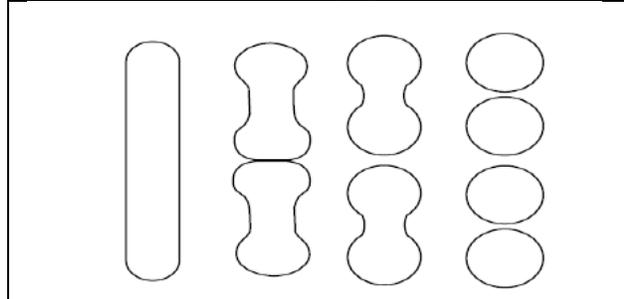
Fig.3 Schematic diagram of the process of transforming cementite lamella to spheroids during spheroidization annealing.
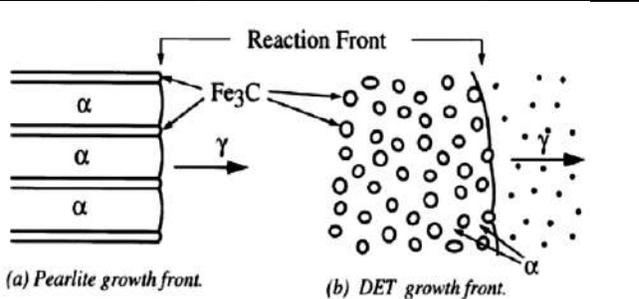
Fig. 4. Schematic diagram of frontal transformation
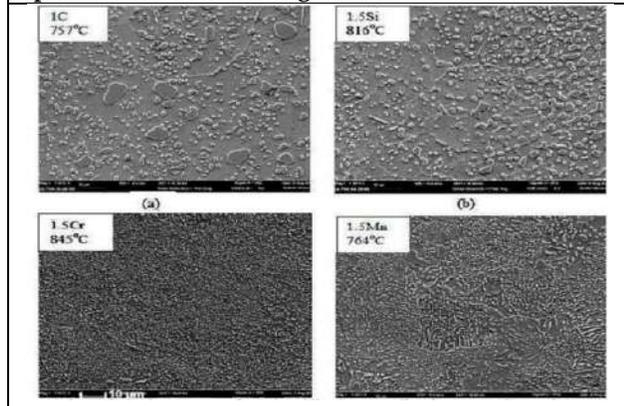
Fig. 5 The typical microstructure after spheroidization annealing for (a) 1C, (b) 1.5Si, (c) 1.5Cr and (d)1.5Mn steels. The austenitizing temperatures for 1C, 1.5Si, 1.5Mn and 1.5Cr steels are 757, 816, 845 and 764 °C, respectively [29]
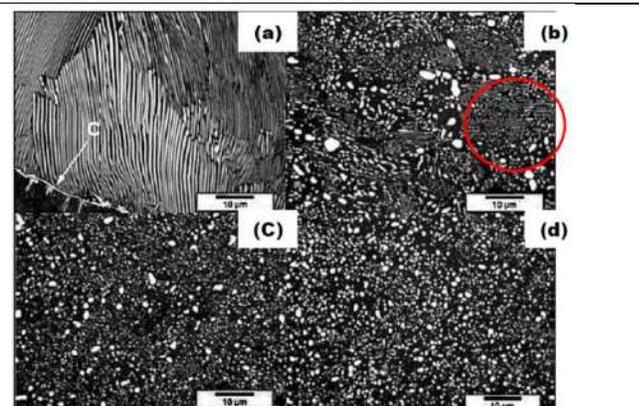
Fig. 6 Microstructure 0,78 %C steel:(a) lamellar perlite without spheroidized (b), (c), (d), spheroidized structure obtained for (b) 0.5Cr, (c) 1.5Cr, (d) 2.5Cr. The presence of cementite C is observed at the grain boundaries of the structure (a).[31]

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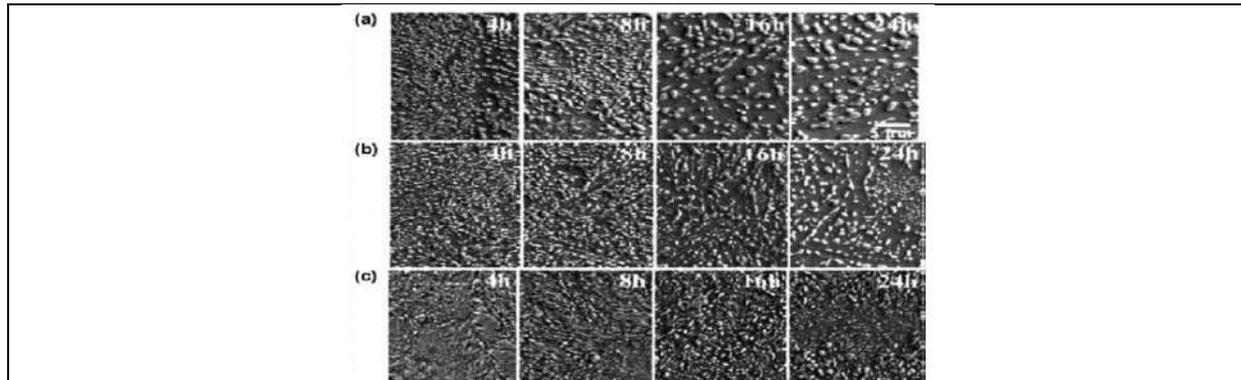
Fig. 7 SEM microscopy of alloys after spheroidization for 2–24 h. (a) Alloy1 spheroidized at 700 °C; (b) alloy1 spheroidized at 650 °C (c) alloy2 spheroidized at 650 °C. (Alloy 1: with 1,93% Al; Alloy 2: without aluminum) [32]

RESEARCH ARTICLE

Intelligent Health Awareness System for Rural Women: A Case of Gujarat

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ABSTRACT

Women are the essential pillar of the family and society as they can shape the future of the entire society. Developing country like India consists of a significant amount of rural area. Because of a lack of education, socio-economic status, and other factors awareness about one's health is overlooked, generally in the case of rural women. This study demonstrates the development of an intelligent healthcare system, especially for rural women. In the era of technology, it is possible to reach millions of women nationwide and educate them about their health issues. The major objectives of this study are to identify basic women's health issues like menstruation, pregnancy issues, sanitation, malnutrition, etc., and to provide awareness regarding these health issues in rural areas using intelligent technology such as fuzzy logic. Further, this study focuses on finding out various government schemes and experts' advice for tackling health issues in rural areas. This paper presents objectives, a literature review, a generic architecture of the system, fuzzy rules, and other details related to the system.

Keywords: Artificial Intelligence, Fuzzy Logic, Rural Women, Health Awareness, Menstruation, Pregnancy Issues

INTRODUCTION

Great well-being is a key measure, which adds to human prosperity and financial development. For any nation, dealing with ladies' health and life must be one of the precedence. Acceptable nutrition for ladies would assist them to serve as productive members of society to develop the consequent health generations. In 2023, Gujarat had 52.11% male population while the female population was 47.88%. Women face extreme changes in and outside of their bodies as they mature, making every stage of their lives feel like an uphill battle. Nowadays women are more empowered than men. But in a rural part of Gujarat women are not aware of the health awareness campaigns. In a time when rural women are susceptible to countless ailments, it is crucial to motivate them to take responsibility for their health and hygiene. From working women to housewives, from poor to richest women, illiterate to educated women all are not aware of common health issues that are phased by most women. Because of lifestyle decisions and ignorance, women's health conditions have recently leaped. A woman's hectic daily schedule may cause healthy living to be neglected. In this modern era women may suffer from common health issues like Menstruation problems, Fertility issues, Thyroid problems, Breast cancer, Depression, Sexual health and bladder issues, Hormonal imbalance, Malnutrition, **Heart diseases,** Maternal mortality, reduction in bone density, etc. women in rural areas have to experience many health-related issues due to poverty, illiteracy, poor quality health facility as well as less knowledge about common health issues. Therefore, to support a woman in a health crisis it is advisable to develop an intelligent healthcare system that will accommodate their specific needs. Additionally, this system will educate women on the importance of encouraging healthy lifestyle choices, which are the best approach to preventing disease, lengthening life, and enhancing quality of life. To fulfill this requirement this research paper will focus on the most common women's issues such as Menstruation problems and Maternal mortality[1][2].

LITERATURE SURVEY

A study by Thane locale in Maharastra shows that a large portion of the juvenile young ladies had a lack of knowledge and awareness about menstruation before menarche. This study has proven that mothers played the most prominent role in providing information to their daughters about menstruation. This research also makes the case that although many of the girls intended to use sanitary napkins during their monthly periods, many were unwilling to do so caused of budgetary limitations. Additionally, several of the study's female participants reported having significant menstrual anxiety, irregular periods, excessive bleeding, and white discharge. The findings of this study should demonstrate various solutions to aware adolescent girls about menstruation and give them special care and support regarding menstruation [3]. The reason for this study is to reveal insight into the feminine state of juvenile young ladies who live in rustic regions near Bhopal as well as their menstrual health-seeking behavior. This study demonstrated that most of the adolescent girls did not take any medical treatment due to feeling shameful and discomfort, lack of proper medical facilities and poor attitude of healthcare workers, cost of treatment, gynecological morbidities, etc. Moreover, this research illustrated common menstrual complaints and healthcare-seeking behavior among adolescent girls[4].The creation and usage of smart healthcare bidets to help avoid numerous human ailments are discussed in this article.

A medical bidet platform and app software based on the Internet of Things (IoT) were created to employ sensors to track users' health data including oxygen levels, pressure, temperature, and pulses. This bidet is used to detect human diseases at early stages. The created medical bidet platform is capable of measuring and transmitting a variety of physiological information that can aid in the early diagnosis of human medical conditions[5]. The possibility for an AI system to provide health awareness messages is introduced and examined in this work. Folic acid was used as a test case since it is a nutrient that is essential during pregnancy. To determine if a cutting-edge AI system is capable of producing health messages to raise awareness about this crucial problem, this project will employ folic acid (FA) as a test case. In particular, the produced messages were assessed as clearer and of greater quality compared to even the most widely shared human communications, were simple to use, and were typically on par with human messages in terms of quantitative attributes. Consequently, the message engine might be utilized to

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reduce the bottleneck in the process of creating health awareness messages[6].This paper demonstrates IOT and Mobile health care. Online personal health records (PHR), SMS treatment and appointment reminders, the emailing of private clinical information, and specialist directing are all features of mobile health care. IoT medical services will complete a reasonable part, for example, RFID labels, sensors or locators, insight hardware, and so on. This framework empowers online interaction with patients, recognizing the patient's form, verification of the patient's mentality, following patients, doctors, and medical equipment shipping, drug management, drug discoveries, and so forth[7].This paper surveys various kinds of conversational specialists utilized in medical services for constant circumstances, looking at their fundamental correspondence innovation, assessment measures, and Artificial intelligence strategies. This paper showed that various advancements have upheld CAs, including autonomous stages, applications conveyed through web or cell phones, short message administrations (SMS), and phones[8].This paper demonstrates the role of AI in healthcare. It likewise shows how Artificial intelligence is valuable in medical care by mining clinical records; planning treatment plans; forecasting health events; helping with tedious tasks; conducting online consultations; aiding clinical independent direction; prescription administration; drug creation; pursuing better decisions and choices; what's more, tackling general medical conditions and so on.

It also reports the AI policies and initiatives taken by the Indian state government. Also shows how AI has become a helping hand during the COVID pandemic. It also lists the various Mobile applications for COVID-19 contact tracing and further investigation[9].This study explores how rural women in India's Tamil Nadu province observe and are aware of health concerns. The study's findings revealed that the respondents had a thorough understanding of health-related issues and were aware of the numerous government efforts and programs aimed at assisting rural women and children in leading healthier lives. The study aims to identify the demographic profile of the women and the awareness of key health issues related to women in rural areas[10]. The many AI technologies employed in healthcare are highlighted in this study. Particularly in the healthcare sector, AI technologies like machine learning, IoT, algorithms, and robotics are used for surveillance, evaluation, cure, and assessment of hazards and advantages. AI may be used for a variety of health-related tasks, including diagnosis, treatment, exchange of information, privacy, assistance, inspection, gathering data, and remote surgical procedures. A knowledge of current AI research and its practical use in the healthcare industry is provided by this review study[11].

This investigation offers advice on how to create an application called Smart Care that will aid pregnant women during a sensitive and important time in their lives. This application provides personalized dietary guidelines, and necessary advice for pregnancy stages and uses its intelligence to take such suggestions to an advanced level. Smart Care also reduces pregnant women's stress and guides them toward a healthy maternity period. The main aim of this development is to help out any woman who is expecting a baby in rural areas[12]. The article describes a system that employs the use of the Internet of Things to track pregnant women's health. The goal of the initiative is to develop a system that can gather and send crucial biometric data about pregnant women's health to a database, make predictions from the data, and let medical professionals treat pregnant patients remotely. The smartphone application's main goals are to employ sensors to monitor a pregnant woman's activity level and to present them with a way to regularly and remotely connect with medics about major concerns relevant to their pregnancies and health[13]. From these literatures survey we have observed the following outcomes shown in given Table 1:

LIMITATIONS AND OBSERVATION

From the above analysis, it has been clearly shown that one intelligent healthcare system is required for rural women to make them aware of health-related issues. From the given literature survey it has been observed that still some research is needed to develop an intelligent system for rural women to make them aware of the most common issues such as Menstruation problems and Maternal mortality. To work in this direction, we can list out the basic aims of this research.

1.　　To develop user user-friendly application for providing basic information about women's health issues.
2.　　To provide expert advice for health and hygiene
3.　　Women can get prompt messages or remindersto take medicines

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4. To provide a proper diet plan for pregnant women.
5. To get reminders for the menstruation cycle
6. To assist women with different health problems and guide them in their very own language in the form of audio, textual content, and images.

PROPOSED MODEL

The following Figure 1 represents the proposed model which is designed to fulfill the above aims. The purpose of the proposed model is to provide expert knowledge and awareness information to pregnant women and young girls about sanitization, menstruation, pregnancy, and gynec related issues.

Users

The users of the proposed model are women, government representatives, social service agents, NGOs, experts, and admin. Women like pregnant ladies and adolescent girls can use this system to get solutions to health-related issues. Government representative, social service agent or NGOs can access this system for any schemes or campaigns for health improvement and nutrition-related helps to women. Experts are doctors who provide different solutions to women's health issues. Admin can update the entire system according to the needs of users.

User Interface

It is a user-friendly application that will be developed using Mobile technology or Web Technologies. Through the user interface users can create their profile to access this system. In the profile module users can input personal, educational, social, and assets information and medical history. To get accurate results through this system user has to provide location information like village, district, season, etc. In government schemes modules, different health-related help as well as financial help is provided to the user. The "Mukhyamantri Matrushakti Yojana" has been introduced by the Gujarat government [14]. Pregnant and nursing ladies will receive nourishing food through this program. The user interface takes basic information such as personal information, professional information, social or family information as well as facilities as input from any woman which is shown in figure 2

Fuzzy System

According to the user's health issues different advisory or fuzzy rules are generated. The proposed model is trained in such a way that according to the health issue, an appropriate solution is generated in the form of multimedia like image, audio, video, or text.

Advisory Rules

To support the proposed model, various fuzzy rules are designed. Here we design the fuzzy rules in Sanitization, Menstruation Period, and Pregnancy and Gynec factors. For Sanitization, we consider three parameters toilet facility, basic medicine, and Sanitary pads available at home or not. If not available, then different awareness related to this is given to the user. Similarly, if a user does not have proper awareness regarding the Menstruation Period, Pregnancy, and gynecology then government-related help and advice from Gynaecologist is given to them. Moreover, the awareness information is given in the form of video, audio, images, or text. The fuzzy rules and their output are shown below:

1. If the marital status is "Single" and Education is "Low" and Age is "Very Low" and Sanitary_facility is "Medium" and Medical_history is "No" and Symptum_intensity is "High" then Young_Adult_Advisory is "True"
2. If the marital status is "Married" and Education is "High" and Age is "High" and Sanitary_facility is "High" and Medical_history is "No" and Symptum_intensity is "High" thenYoung_Adult_Advisory is "True"
3. If the marital status is "Divorcee" and Education is "Medium" and Age is "Middle" and Sanitary_facility is "Low" and Medical_history is "Yes" and Symptum_intensity is "Low" then Young_Adult_Advisory is "True"

4. If the marital status is "Widow" and Education is "Medium" and Age is "High" and Sanitary_facility is "High" and Medical_history is "No" and Symptum_intensity is "Low" then Young_Adult_Advisory is "False"

From the above fuzzy rules, fuzzy membership functions are developed shown as in Figure 3

CONCLUSION

With the widespread use of the Internet, this work focuses on the implementation of an intelligent health system for rural women that would communicate through the Internet for better health. A smart health system guides and informs about healthy lifestyles to support women in every health crisis. Basically, this study aims to highlight the basic factors like disinfection, menstruation and pregnancy and gynecological problems among rural women. In addition, the government should allocate more budget funds and focus on village infrastructure to ensure equitable health care for rural women. In the future, we can develop a model that covers more women's health problems such as breast cancer identification, malnutrition, iron deficiency anemia, reduction in bone density etc. Such a health system is also suitable for men, children and the elderly in a certain area. Also it becomes further helping hand during uncertain epidemic like Covid- 19.

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TABLE I. OUTCOME OF LITERATURE REVIEW

Sr. No	Reference	Application Developed	Techniques	Remarks
1	Menarche and Menstruation in Rural Adolescent Girls in Maharashtra [3]	No	A convenience sampling method is used for data collection	• Study with a relatively small sample size. • Study focus on Menarche and Menstruation related awareness
2	Health care for common menstrual problems in Adolescent girls at rural setting in central India: A mix-method study[4]	No	Data collection is done using semi structured questionnaire multistage cluster sampling	• Study focuses on the menstrual condition of adolescent girls • Minorities and people living in rural areas were left out
3	Development and Implementation of Smart Healthcare Bidet [5]	Yes	IoT based medical bidet (Mobile App) is developed.	• Monitors users' health information such as oxygen, pressure, and temperature
4	AI for health message generation: an empirical study using a large language model (LLM) and prompt engineering [6]	Yes	AI system to generate health awareness messages	• Compare AI generated message with human generated message • Folic acid related information
5	Review on smart health care [7]	No	IoT and Mobile technology	• General health awareness using IoT and Mobile
6	A Systematic Review on Healthcare Artificial Intelligent Conversational Agents for Chronic Conditions [8]	No	-	• It is focus on different technologies used for chronic conditions rather than any health related information
7	Artificial Intelligence and Healthcare in India [9]	No	AI technology	• How AI is applicable in healthcare. • Provides list of Mobile App used during COVID-19
8	Awareness and Perception of Health Issues Among Rural Women [10]	No	Convenient sampling method is applied for collecting data	• The findings of the study revealed that lack of primary health care facilities are the key factor for health issues among rural women
9	A systematic literature review of artificial intelligence in the health care sector: Benefits, challenges, methodologies, and functionalities [11]	No	AI technology	• This research highlights the uses of various AI technologies such as machine learning, IoT, algorithms, and robots in health care sector.
10	Smart Care: An Intelligent Assistant for Pregnant Mothers [12]	Yes	Mobile Application	• A woman will be supervised by Smart Care, an intelligent support system, throughout all aspects of her pregnancy.
11	Technology for Continuous Long-term Monitoring of Pregnant Women for Safe Childbirth [13]	Yes	Mobile technology, Signal Processing, IoT	• This paper outlines a system for monitoring the health of pregnant women • This system can reduce pregnancy related morbidity through remote monitoring of the health
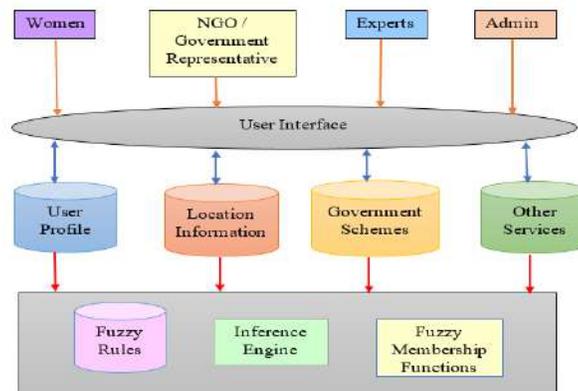
Fig. 1. Proposed Model

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Fig. 2. Input Data

Fig. 3. Different Fuzzy Membership Functions

RESEARCH ARTICLE

AZFa Sub-Region Micro Deletion Screening for Infertility in Males

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ABSTRACT

The term infertility is disease of the male or female reproductive system defined by failure to achieve a pregnancy after 12 months or more of sexual intercourse. It is major health problem affecting 15% of couples worldwide. About 9% of male and 10% of female aged between 22- 44 reported infertility problems. Approximately 10-15% of infertile men are azoo spermic. Y-chromosome micro deletions represent the absence of DNA segments from the Y- chromosome especially azoo spermia factor (AZF) and is considered the most common genetic cause of male infertility.In the present study genomic DNA was isolated by using phenol/chloroform mextraction protocol. Molecular genetic analysis using STS-PCR helps us to identify micro deletions in Y chromosome specifically in AZFa sub-region. Total 50 samples analyzed for sperm morphological defects and Y-chromosome micro deletions. The prevalence of deletion at AZFa sub region was 0% in the present study due to limited numbers of STS markers and sample size.

Keywords: Male infertility, Y chromosome micro deletions, STS-PCR

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INTRODUCTION

Infertility is one of the major health problems affecting about 10-15% of couples [1]. About 9% of male and 10% of female aged 22 to 44 reported infertility problems. Large scale studies have shown that about half of all cases of infertility occur due to female factors, 20-30% male factors and 10-20% due to common causes of both gender [2]. Infertility classified into two types, primary infertility and secondary infertility. Primary Infertility refers to couples who have no previous pregnancy and secondary infertility refers to couples who have history of previous pregnancy. Infertility cause by Lifestyle factors, Environmental factors, Genetic factors, Hormonal factors, Pathological causes and Unknown causes. Due to the existence of both male and female factors that complicate any estimate that may simply focus on the woman and a result of a pregnancy diagnostic or live delivery, determining the prevalence rates of infertility throughout the world is challenging. One in every four couples in developing countries had been found to be affected by infertility[2]. Approximately 10-15% of infertile men are azoo spermic. Y-chromosome micro deletions represent the absence of DNA segments from active part of the Y chromosome [3].On the Y-chromosome, micro deletion of azoo spermia factor (AZF) is located and it is considered the most common genetic cause of male infertility. AZF subdivided into four non-overlapping sub-regions:-

1. AZFa (Proximal),
2. AZFb (Middle),
3. AZFc (Distal),
4. AZFd (Between AZFb and AZFc).

On the Y chromosome, several sequence tagged sites (STS) have been created and mapped for the above AZF region [1]. STS are known sequences of genomic DNA that can be amplified by PCR [5-6].After Klinefelter syndrome, Yq chromosomal micro deletions are the second most significant genetic cause of spermato genic arrest in male infertility[7]. as it contain several genes which are involved in spermatogenesis [8-1]. A chromosomal deletion that covers many genes is referred to as a micro deletion, but not large enough to be detected by standard cytogenetic techniques. Micro deletions are more common in azoos permic and severely oligozoo spermic males, according to studies. [9]. Different testicular histology profiles, such as Sertoli cell-only syndrome (SCOS), hypo spermatogenesis (HS), spermatogenic arrest (SGA), and SCO type II syndrome, are linked to these micro deletions[8-1]. In order to better understand how this type of defect may contribute to male infertility, we are examining the functions of numerous genes on the Y chromosome in this study.

MATERIALS AND METHODS

After extensive survey samples from Oligozoo spermia, Azoospermia and Normozoospermia individuals was collected after explaining study purpose and getting written consent. Research study ethically approved from institute ethical committee S.G. Patel Ayurveda Hospital & Maternity Home, New Vallabh Vidyanagar, Anand. Oligozoo spermia and azoo spermia samples between age group 22-45 years, from different areas of Rajkot district and men with primary infertility and person attending IVF clinics. Person with proven immunological, hormonal or other causes of male infertility, males having age above 45 years. Analysis of Y-chromosome micro deletions was carried out by using polymerase chain reaction(PCR). The genomic DNA from the infertile as well as normal subjects was isolated by using phenol/chloroform extraction protocol. Subsequently, the isolated genomic DNA concentration was measured by using Nanodrop spectrophotometer at 260 nm and the quality of the DNA were checked on 1.8 %agarosegel.DNA was extracted from semen according to standard procedure and the presence of microscope deletions of the AZF a region on the Y chromosome long arm was analyzed using a STS-PCR for Y-Specific markers, including sY81(AZFa) and sY84(AZFa). PCR was carried out in a 25 µl reaction volume. The reaction mixture contained 5 µl of template DNA, 5.4 µl of nuclease free water, 1.0 µl of each primer, 12.5 µl of PCR master mix(2X),

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0.1 µl of 5 % DMSO. The genomic DNA of females was used as a negative control. Polymerase chain reaction were performed by denaturing DNA for 5 min at 94°C. Thirty-five cycles consisting of 30 second denaturation at 94°C, 45 seconds annealing at 57°C and 60 seconds extension at 72°C were performed to amplify the specific STS. 60 seconds finally extension at 72°C was performed. On a 2% agarose gel,microscopic PCR products were examined, stained with ethidium bromide stain (0.5 µg/ml), and then seen under UV illumination. Under the same laboratory conditions, single-primer pair PCR verified the deletion at each STS. In case of presence of micro deletions in STS, PCR was repeated thrice to confirm the deletions.

RESULTS AND DISSECTION

Total of 50 semen samples were obtained from Bliss IVF Laboratory, Rajkot. Information related to routine analysis of semen samples like semen volume, colour, viscosity, motility, concentration etc received from the collection place. The age of the men ranged between 21-40 years and majority of them between 25-35 years. On the basis of semino graph result especially sperm counts, samples were characterized as Normozoospermia, Oligozoospermia and Azoospermia. In all this samples, 29(58%) samples were Normozoospermia, 17(34%) samples were Oligozoospermia and 04(8%) samples were Azoospermia. Samples were labelled with the unique ID number. DNA was isolated from semen samples using standard phenol-chloroform methods. It was subjected to qualitative analysis using agarose gel electrophoresis. All the isolation DNA were separated on 1% agarose gel that shown DNA bands of variable size, due to different concentration. Out of 50 samples, 17(34%) showed less than 40% motility, which is well below to the semen analysis manual's standard normal level and is classified as asthenozoospermia [19].One of the most fascinating and relevant findings from all of the samples was that 8(16%) sample had abnormalities in all the three structural part of the spermatozoa, severely lowering motility and the sperm count of this sample was also quite low. The motility value of that sample was barely 5%. Many studies have found that morphologically abnormal spermatozoa have low motility and fail to reach their target, resulting in infertility. [19].

To confirm presence of Y chromosome and distinguish a negative result from technical failure an STS for SRY (sY14), which is localized on Yq. While observing the PCR products under 2 % agarose gel the product bands were falling within ladder marked region of 100 bp, SRY gene indicate that DNA is present on Y chromosome which is of 472bp shown in **Figure 3**. Among the 50 patients included in this study, 29(58%) patients were Normozoospermia, 17(34%) patients were Oligozoospermia and 04(8%) pateints were Azoospermia. In 50 infertile males, we were not found any Y chromosome micro deletion. While observing the PCR products under 2% agarose gel the product bands were falling within ladder marked region of 100 bp, Bands which indicates the normal sY 81 gene which is of 209 bp and sY84 gene which is of 326 bp. The result of 2% gel electrophoresis of PCR product shown in **Figure 4 and Figure 5** respectively sY81 and sY84. In most investigations, sperm abnormalities have been linked to male infertility and sterility. Environmental, genetic, or a mix of these factors can cause sperm structural defects. The morphological faults that are visible on clinical inspection that are more significantly deficient examples of sperm abnormalities. The AZF micro deletion in the Yq chromosome is the second cause of spermatogenic stoppage after Klinefelter syndrome [11]. One Oligozoospermia sample had greater morphological abnormalities and a sperm count that was below the normal range. Various morphological deformities were identified, including spermatozoa with tapering heads, spermatozoa with bent necks, two-tailed spermatozoa, and short-tailed sperinatozoa [2].

Khabour et al, evaluated micro deletions in the AZF region of the Y chromosome in 100 men who were infertile for unclear reasons. Micro deletions in the AZF region were found in 3 out of 36 azoospermic infertile males, whereas no micro deletions were found in oligozoospermic infertile guys. The prevalence of AZF micro deletion among azoospermic males was found to be around 8.3% in this study. Our current findings are in agreement with the prevalence that was reported from chine (8.6%) and Netherland (8.1%). The prevalence of AZF micro deletions (8.3%) observed in this study is higher than that was reported (7.6%) in India, due to limited STS. The value of micro deletion in this study (8.3%) is 3% lower than that was found in Tunisia (11.8%), Japan (11.7%) and United State (11%).All revealed a relatively low incidence of AZF micro deletions. The technique used to identify deletions, the

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inclusion criteria, and sample sizes may all have an impact on the measured frequency of AZF micro deletions among azoospermic infertile guys. In their study sample, no micro deletions were detected among 64 oligozoospermic infertile males [12]. Mushtak et al, studied 46 patients, Only one of these 46 patients (2.2%) with primary infertile azoospermia had a full AZFa deletion; the remaining 45 patients (97.8%) had partial deletions. Their study was able to incorporate more information concerning the incidence of AZFa in Iraq, which had previously been scarcely recorded. They discovered a substantially greater prevalence of AZF a micro deletions in their region than in other prior studies from various nations. The incidence of AZF a micro deletions was found to be 61.3 percent in 75 infertile guys with azoospermia and severe oligozoospermia (46 patients) [13]. AZFa micro deletions were not discovered in any patients in earlier Iraqi investigations [14-15]. One of the most prevalent molecular genetic causes of male infertility is submicroscopic deletions in the AZF zone of the long arm of the Y chromosome [16]. The majority of these micro aberrations recur as a result of inter chromosom alhomologous recombination inside the area, according to research [17]. They damage one or more genes, resulting in a variety of spermatogenesis abnormalities. It's been proposed that genes in the AZF region have a regulatory role in the germ cell cycle and meiosis. When evaluating the literature data on micro deletions in the AZF sub regions, differences in the reported frequencies were discovered [18]. Dzhglovet et al, discovered micro deletions in the Y chromosome were discovered in 12% of 100 males with azoospermia. 66.7% of these micro deletions were detected in the AZFb area, 41.7 % in the AZFc region, 33.3 % in the AZFd region, and 8.3 % in the AZFa region, according to the authors [19]. Micro deletions were found in 4 (9.75%) AZFa patients, 5 (12.19%) AZFb patients, and 9 (21.95%) AZFc patients among the 41 azoospemia patients. Similarly, micro deletions were found in 5 (5%) of AZFa patients, 8 (8%) of AZFb patients, and 15 (15%) of AZFc patients out of 100 oligozoospermia patients [11].

CONCLUSION

Characterization of 50 semen samples of fertile and infertile males (Normozoospemic, Oligospermic and Azoospermic), morphological profile revealed that there is a involvement of morphological defects in the normozospermic (4% or more) samples also. Genomic DNA isolated from 50 samples were of good quality confirmed by agarose gel electrophoresis. SRY gene fragment amplified was of 472 bp in all the samples which indicate that gene was present on Y chromosome. sY81 gene fragment amplified was of 209 bp which indicate no micro deletion on Y chromosome and sY84 gene fragment amplified was of 326 bp which indicate no micro deletion on Y chromosome. If bands were absent it indicates micro deletion of Y chromosome. Genetic evolution of AZFa sub region by using STS-PCR technique showed deletion in AZFa sub region. AZFa sub region micro deletion among 29 Normozoospermia, 17 oligospermic and 4 Azoospermic samples revealed absence of deletion in sY81 gene and sY84 gene. The prevalence of deletion at AZFa sub region was 0% in the present study due to limited numbers of STS markers and sample size. Based on the results of this study that infertility in selected population has independent effect of both sperm morphological defects and micro deletion, as no clear-cut correlation was observed between micro deletion and morphology of sperm. The Y chromosome deletion has a diagnostic, prognostic and preventive value. The analysis are very important in infertile males to avoid empirical and expensive treatments for the improvement of fertility. Development of such a new molecular technique and standardized protocols may provide reliable results with cost effective analysis of Y chromosome micro deletion. This study together with other STS markers may help in developing in vitro screening test for Y chromosome micro deletions at fertility clinic.

ACKNOWLEDGMENT

CONFLICTS OF INTEREST

There are no conflicts of interest.

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Table 1: Primers sequence and size for SRY and AZF a genes [10].

STS	Y-Region	Primer sequence	Size(bp)
sY14	-	Forward5'- GAA TAT TCC CGC TCT CCG GA -3' Reverse5'-GCT GGT GCT CCA TTC TTG AG -3'	472 bp
SRY	AZFa	Forward5'- AGG CAC TGG TCA GAA TGA AG -3' Reverse5'-AAT GGA AAA TAC AGC TCC CC -3'	209 bp
sY84	AZFa	Forward5'- GAA TAT TCC CGC TCT CCG GA -3' Reverse5'- GCT GGT GCT CCA TTC TTG AG -3'	326 bp
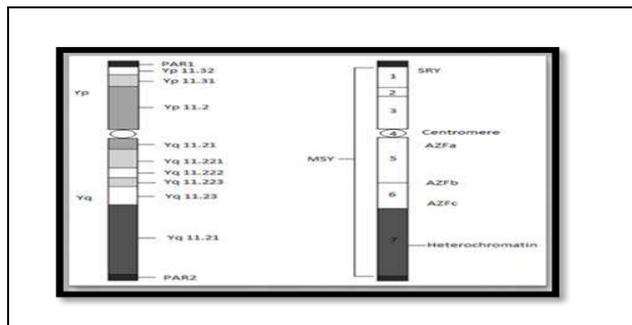
Figure 1: Representation of cytogenetic partitions of Y chromosome and showing pseudo-auto somal region-PAR1 and PAR2 (left figure). Seven interval map (right figure) of Human Y chromosome and AZF regions-AZFa, AZFb and AZFc [4].
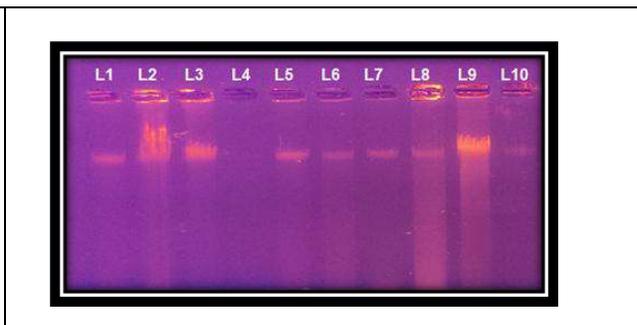
Figure 2: Electrophoretic pattern of semen DNA samples in 1% agarose gel, Lane 2,9: DNA from Normozoospermic samples, Lane 1,3,8,10: DNA from Oligospermic samples, Lane 4,5,6,7: DNA from Azoospermic samples.
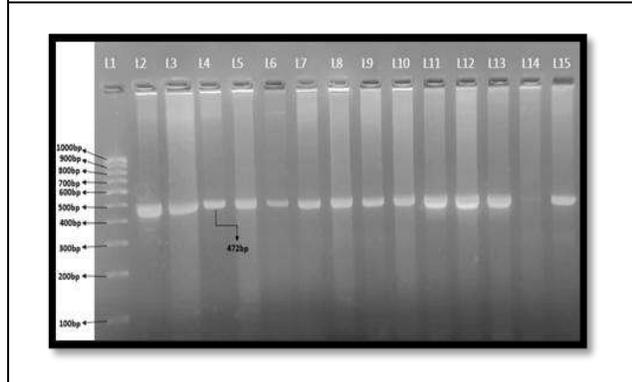
Figure 3: Electrophoresis pattern of PCR products (472bp) generated by amplification of sY14 gene specific marker. Lane 1: Low range marker (100 bp), Lane 1-12,14: DNA isolated from Normozoospermic samples, Lane 13: DNA from Azoospermic sample.
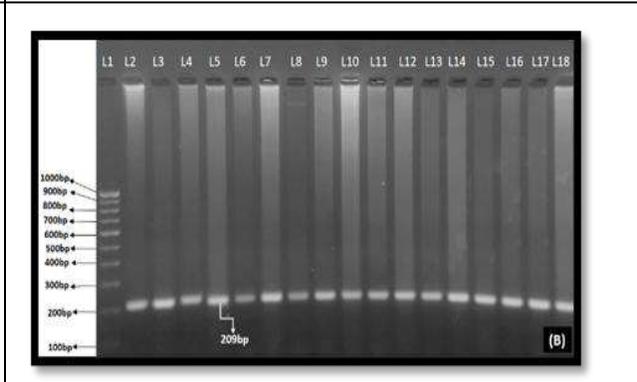
Figure 4: Electrophoresis pattern of PCR products (209bp) generated by sY81 gene specific marker. Lane 1: low range ladder (100bp), Lane 2,3,5,7,9-14,17,18: PCR products of Normozoospermic samples, Lane 4,6,8,15: PCR products Oligospermic samples.

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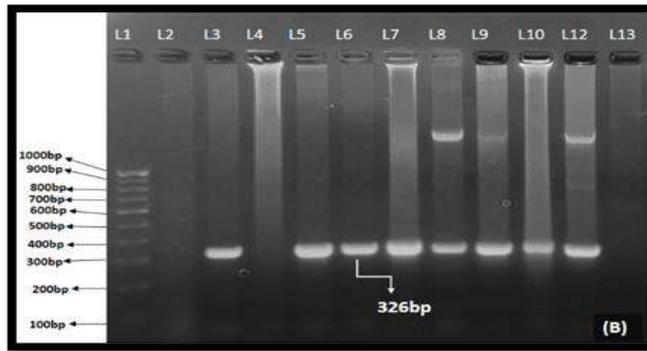
Figure 5: Electrophoresis pattern of PCR products (326bp) generated by sY84 gene specific marker. Lane 1: Low range ladder (100bp), Lane 2,3,5,7,9-12: PCR products of normozoospemic samples, Lane 13: Negative control.

RESEARCH ARTICLE

Crops Recommendation based on Soil and Weather Prediction

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ABSTRACT

Soil is important to humans and all life on earth as it serves as a source of agriculture, food and medicines. There are different types of soil, each with different mineral, humus and organic matter compositions and different properties that can be used to grow different crops. Proposed work implements a system for farmers to recommend crops based on weather forecasts and suitable soils. This proposed system will help farmers accurately identify crops without worrying about future weather or suitable soil. Through this system, farmers can get more profit. The system will help farmers by prediction of yields depending on soil parameters such as pH, nitrogen, phosphorus, potassium, temperature, humidity and precipitation soil type & various machine learning algorithms such as Convolutional Neural Network (CNN), Random Forest Model, Gradient Boosting, decision tree, GB will be used in the proposed research work

Keywords: Machine learning, crop, soil, humidity, rainfall

INTRODUCTION

Agriculture is the mainstay of the Indian economy. India is also known as an agricultural country. 50% of the workforce in India is engaged in agriculture [1]. Soil is the most important and necessary in agriculture. But now farmers also use traditional methods. Traditional methods do not bring good results to the farmers and do not increase the yield. High yield requires good soil. For this reason, a land survey was carried out. Soil science is more important to him than the main business of agriculture. Productivity and good harvest depend on the soil. Soil tests are important because they provide information about all the nutrients found in the soil, such as Ca (calcium), K (potassium), and N (nitrogen). Farmers in many parts of India, especially in the state of Maharashtra, are facing disruptions in their crops and yields [2]. They do not care about the availability of nutrients in their fields. They

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cannot pay the loan because the success rate is low. We are committed to creating this system to help farmers decide which crops to plant for their profit. This information includes nutrients found in the soil and rainwater of farmers in an area. Based on its nutritional value, our body can predict the type of soil. A list of crops that can be expected to grow in a soil based on soil type systems. As a result, yields increased and farmers made more money with this new method. We produce machines with advanced technology. We use machine learning to build the system. Machine learning focuses on building computer programs that can access data and use it to learn from it. Machine learning allows models to be built from data models and can make decisions based on experience [3].

Motivation

Today's trend is precision agriculture. Precision farming is a modern farming technique that uses information about soil, soil type, crop yield, weather and tells farmers to plant the best farms. This machine can reduce crop spoilage and help farmers make informed decisions about their farming strategy. To solve the current agricultural problem, a good consulting system is needed to help farmers make informed decisions before they start planting.

LITERATURE SURVEY

Vrushali C. Waikar, Sheetal Y. Thorat, et al. proposed a land classification based on crop prediction using machine learning with classification [1]. Therefore, the main goal of the system is to create a model that will help farmers understand what crops should grow in a particular soil type. In this process, we use machine learning techniques to help identify crops based on soil distribution or soil series. The model only shows the soil type and shows suitable crops according to the soil type. Different classifiers are used here and products are recommended according to the model. Both of these datasets are used in this document. The first dataset is the soil dataset and the crop dataset. The soil dataset contains attributes such as PH, conductivity, nitrogen, phosphorus, potassium, soil type, and the product dataset includes attributes such as soil type and product names in this form. Mahendra N, Dhanush Vishwakarma et al. reported on machine learning for crop forecasting [2]. Most suitable product for a particular soil is recommended by this proposed work taking into account parameters such as annual precipitation, temperature, humidity and soil pH. Of these, the annual precipitation is estimated by the system itself using the data of the previous year by the other parameters, including the SVM method, must be provided by the user. The system uses the NPK value from the description entered to present the NPK requirements for the suggested crops in the Output section. The system also uses the market value and expected yield of the crop. Data about crops is gathered from the Kaggle website. 22 distinct products and 7 attributes, including temperature, humidity, and precipitation, and N, P, K, and PH, make up the 2196-byte tag file. Deletion: Delete the author and affiliation lines for the second affiliation.

Girish L, Gangadhar S, Bharath TR and others. A method has been proposed to predict crops and precipitation in the Tumakuru region using machine learning [4]. In this article, they discuss the performance of several learning machines, such as linear regression, SVM, KNN techniques, and decision trees, as well as different learning approaches for forecasting precipitation and crop yields. They came to the conclusion that SVM is the best technique for forecasting precipitation throughout this phase. In this post, we run a prediction test utilizing real-time information gathered from government and agricultural websites. By performing a predictive analysis of the data collected, we can help farmers choose whether crops are suitable for rainfall and crop prices. Suruliandi, G. Mariammal, and S.P. Raja proposed a crop prediction method based on the characteristics of the soil environment using a special selection tool [5].Selecting the right traits for the right crop is an important part of the selection process, especially for forecasting. In this study, different package options were examined compared to crop forecasting using a classification system that indicates the crop suitable for the land. Experimental results show that recycling eliminates the bag changing process more efficiently than other methods. The dataset for this article was collected from the website: www.tnau.ac.in and Ministry of Agriculture, Sankarankovil Taluk, Tenkasi District, Tamil Nadu, India. The database contains 1000 events and 16 features, 12 of which are location features and 4 are environmental features. Ph, EC, OC, N, P, K, S, Z, B, FE, MN, CU, precipitation, texture, season.

Jitendra Chavan, Nagesh Pawade et al. He proposed a method for product prediction using the Naive Bayesian algorithm [6]. In this project, use machine learning techniques to create a web application that will predict crop yields by applying machine learning algorithms to historical crop data using Python libraries such as Pandas, NumPy, Matplotlib, seaborn, and sklearn. Data collection is the most important part of this project. There is a lot of information from various websites used to train models. Our database contains more than 10,000 records related to crops, including state, region, season, temperature, precipitation, region, crop, soil, soil. Completed applications will help farmers decide which crops to plant in the field. This project is used to find information about crops that will be used to produce good and profitable crops. This improves our Indian economy by maximizing crop yields. This article focuses on crop forecasting and yield calculation with the help of machine learning techniques. There are many machine learning methods to calculate accuracy. Use a system to forecast crops by collecting historical data. Technology helps farmers decide which crops to plant in the field.

Sachithanandam, Vidhya, T. Sasilatha presented soil and weather-based crop growing recommendations [7]. Analysis of the weather forecast using data mining techniques has achieved good results and can be considered as an alternative to traditional measurement methods. This study describes the ability of various algorithms to predict various weather events (eg temperature, hurricane) and concludes that important techniques such as progression, clustering, forecasting and classification algorithms are required to predict weather events. As the size of the training set increases, the accuracy first increases and then decreases up to a certain limit. The results show that the proposed model produces very good results compared to other data mining prediction techniques. Although we only present the results for the minimum and maximum values, the model is able to predict all available features. The efficiency and simplicity of the model make it suitable for use in short-term electronic equipment and management organizations.

Prasad Gavas, Mrunal Jamsandekar et al. prepare the recommended crops [8]. Analysis of soil data to control for nutrients such as N, P, K and pH values and predicted precipitation for the area using C 4.5 and multiple linear regression algorithms, respectively. The system recommends crops based on the two criteria above.On the front end we share different models for farmers and managers. In the future, we may plan to create recommendations for products that take temperature into account. The system will suggest suitable products for soil conditions based on nutrients, rainfall and temperature. Sk Al Zaminur Rahman, Kaushik Chandra Mitra, proposed a method for soil classification using machine learning and soil series based crop recommendations [9]. The study was carried out on the land registry records of 6 upazillas in the Khulna region. The model has been tested using different types of machine learning algorithms. Bag tree and K-NN showed good accuracy, but among all classifications, SVM has the highest accuracy for soil classification. The proposed model is characterized by developing appropriate data and machine learning algorithms. The accuracy of land classification and recommendations for specific crops are better than many available methods. In the future, we will focus on providing recommendations on fertilizers and add information from other regions to make these models more reliable and accurate. We created a data collection using Upazilla codes, map cells, and lecture notes. Two datasets are used: the soil dataset and the crop dataset. The soil dataset contains class-labeled chemical signatures for the 12 soil chemical properties of the soil used in our method

Dharavath Ramesh, Sonal Jain, proposed an integrated machine learning [10] method for climatebased crop selection in two stages: 1) seasonal climate and 2) required crop production analysis. It uses a recurrent neural network (RNN) for seasonal weather forecasting. After that, eligible crops are classified according to the random forest classification algorithm. Meteorological data is collected from NRSA Hyderabad station and includes five years of data on weather parameters such as temperature, humidity, sunshine hours, wind speed, wind direction and other things. This scheme represents a new weather-based crop selection method for cropland selection based on weather forecast and soil availability. M.Kalimuthu, P.Vaishnavi, M.Kishore proposed supervised machine learning using Naive Bayesian Gaussian classifier and supported algorithm [11] to predict crop yield. Therefore, the seed input parameters are estimated based on the given output. This program can be of great help to poor farmers who have no knowledge of predicting the future of crop growth. In the future, it will continue to recommend recommended fertilizers, field instructions and suitable products. Additionally, monitoring of sunlight and the health of crops is thought to be

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considered to achieve a better harvest. In the naive Bayes approach, the model is 97% correct. Support method is used to increase accuracy. In the promotion process, weak rules should be found and these rules should be given in a way that strengthens them. Weak rules are found through an iterative process. Weak rules are found by the distribution of the Naive Bayes algorithm. Maaz Patel, Anagha Rane and Vansh Patni developed an intelligent system that can recommend suitable products for farmers in India [12]. The system will help farmers choose the best crop based on factors such as nitrogen, phosphorus, potassium, pH, humidity, temperature and precipitation. By using this research we can make the country efficient and benefit from this technology. This research can increase the country's products and profits through the use of this technology. In this way, farmers can grow the necessary crops, increasing their income and the total income of the country. We evaluated machine learning algorithms and found that decision trees and Gaussian NB have the highest accuracy.

Purposed Work
We propose a crop recommendation which takes into consideration all the appropriate parameters including N, P, K, PH, temperature, Humidity, rainfall, and soil condition, to predict crop suitability. In our proposed system it recommends crops with weather forecasting and soil matching.

Data Collection
 The data we use are fertilizer data, crop data. First we will import the file. There are two datasets in this project, the first one is the crop dataset which includes the characteristics such as temperature, humidity, precipitation and crop type. The second is the Fertilizer dataset, which provides information about soil quality, such as the amount of phosphorus, nitrogen, and potassium in the soil. It also gives information about the pH value of the soil.

Data Preprocessing
Data preprocessing is a process used to transform raw data into clean data. This step is a very important step in machine learning. Preprocessing includes interpolation of missing values, capital letters, spaces, appropriate data, and subtraction functions. The type of dataset is very important f or analysis. The first step is data preparation, which includes several steps to clean up the data. Here we check for an empty value and discard it if it does. We will also convert the data of word from uppercase to lowercase. The next step is to find the unique items in the two datasets, then we will feed these unique items into the two newly created variables. Now that our data has been s successfully processed, we will save two sets of data for later use.

Data Integration
Data integration is the process of merging data from several disparate sources. In data integration we are merging our two data sets Crop and fertilizer data. After merging of crop data and fertilizer data then we identify unique label (crops) in dataset.

Data Visualization
Data visualization refers to the graphical representation of data in a visual format such as charts, graphs, maps, or diagrams. It is a powerful tool that helps analysts and decision-makers understand data patterns, relationships, and trends more easily and intuitively. Here are some commonly used data visualization techniques: Bar chart, Line chart, Heat chart, Pie chart etc. Correlation visualization of feature.

Feature Extraction
A special label with the name of the product is reserved, taking into account features such as nitrogen, phosphorus, potassium, temperature, humidity, pH, precipitation. The algorithm used in this project will use the tag names to predict the crop. This step involves training and testing the input data. Loading data is divided into 2 groups such as training data set and test data set with 80% or 20% separation such as 0.8 or 0.2. Classes are used as input data in the education system. In this step, supporting information for forecasting and classifying work and estimates for classification are generated. Test the data during the test section. The final data is generated during the preprocessing

and processed by the machine learning module. Separate characteristics (N, P, K, temperature, humidity, ph, precipitation) and plot (crop).

RESULT

The model was trained and tested using a total of 5 machine learning algorithms on the prepared data. These 5 algorithms are supervised algorithms that will make binary classification. In our project, we use gradient boosting as it is, as the name suggests, a combination of decision trees and clustering models. The Gradient Boosting model collects the training data from each node of the tree and separates the weak training data from the training data for higher prediction. Reinforcement is a learning process that trains models in the order that each new model tries to fix the previous model. It turns a weak student into a strong student. We can solve the classification and retrieval problem using the gradient boosting method [14]. We employed different Machine Learning algorithms and their corresponding outcomes are presented in Table 5.1. Among the algorithms, gradient boosting demonstrated the highest accuracy of 0.9931%. When compared to Gaussian naive Bayes, Decision Tree, Support Vector Machine, KNN, and Random Forest, gradient boosting outperformed them in terms of accuracy. From the above mentioned comparison Fig 5.1 shows Gradient Boosting Algorithm gives 99.9931% while comparing with other algorithm. When comparing the Gradient Boosting accuracy with the other algorithm's accuracy in table 5.1.

CONCLUSION AND FUTURE SCOPE

The proposed machine learning algorithm gradient boosting can predict the crop with high accuracy compared to other classification methods. We present the analysis of soil data and climate data, respectively, using gradient boosting algorithms to analyse nutrients such as N, P, K and pH levels, humidity, temperature and cloud weather forecast for the area. There is still a lot to explore in machine learning because there may be new algorithms and ideas in the future. Our article is a simple concept for crop forecasting. This article focuses on crop yield and crop yield prediction with the help of machine learning algorithms. The system was created in response to rising suicide rates among farmers and to help farmers become financially strong. Collect, learn, and train on relevant data using machine learning tools. We need to gather all necessary information by providing GPS location of the land and we can predict the crop by providing GPS location field to get access to rain gauge from government.

ACKNOWLEDGEMENT

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Table 1 Result

ALGORITHM	ACCURACY	F1 SCORE	Crop
Decision Tree	91.3636	0.91	Rice
GaussianNB	99.0909	0.99	Rice
SVM	97.7272	0.98	Papaya
Random Forest	99.0909	0.99	Rice
KNN	97.5	0.97	Rice
GradiantBoosting	99.3181	0.99	Rice
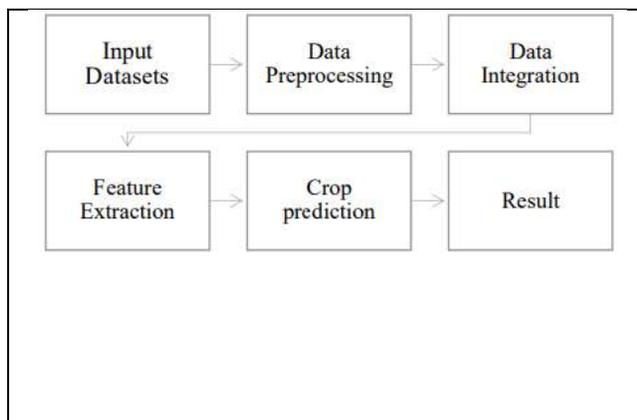
Figure 1.purposed workflow
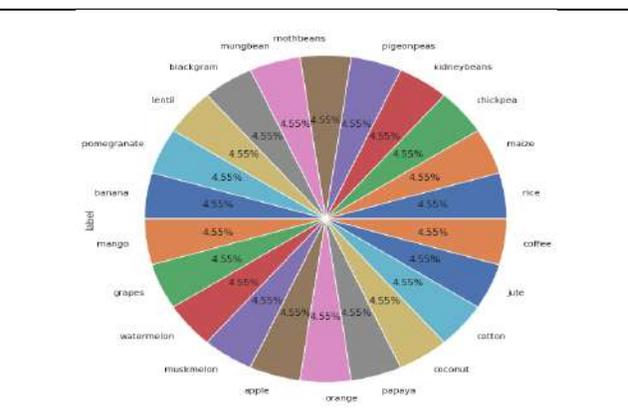
Figure2 .Identify unique crop

Figure 3. Heat Map
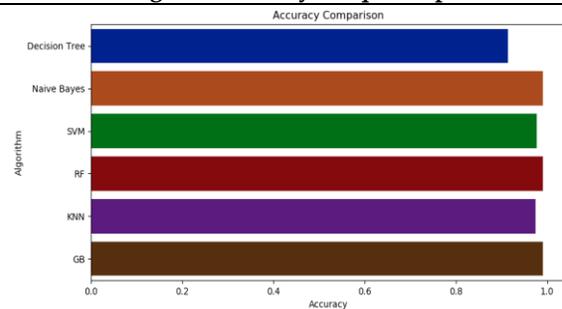
Figure 4. Accuracy comparison chart

RESEARCH ARTICLE

Calibration of Sensor and Data Acquisition for Homely Gases using Arduino

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ABSTRACT

A metal oxide semiconductor (MOS) gas sensor has the capability to detect volatile and dangerous gases in the environment. This type of sensors has been extensively utilized in environment monitoring, healthcare, food industry and other areas. One such MQ-2 gas sensor is highly sensitive to LPG, propane, smoke, and methane gases but need the calibration. There are different ways to calibrate the gas sensor, but they are quite expensive and time-consuming. To find the optimized way 2-point and 4-point calibration methods were used to observe the sensor response using the Arduino Uno module and found to be quite satisfactory. Data acquisition system implemented here was used for monitoring gas response to study homely gases and hence preventive actions could be taken. With PLX-DAQ software, the system was able to collect and store data in spreadsheet.

Keywords: Arduino UNO, Data Acquisition, MQ-2 gas sensor, PLX-DAQ software

INTRODUCTION

The gas sensors are becoming the intangible part of human's need in their living spaces. This has increased rapidly in recent years, but in turn environment around us is adversely affected [1]. Inhaling toxic gases can lead to problems like lung cancer, headaches, vertigo, asthma, and other cardiovascular problems [2]. In view of the mentioned causes a need arises to study the adverse effects of it and to how resolve it. An attempt is made to study the MQ-2 gas sensor for homely gases and consider its behaviour for the development of a sensor and system to monitor pollutant gases.

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The MQ-series sensors have good potential in gas sensing. They are made up of metal oxide (MOX) semiconductor. Because of good sensitivity and economical **[3]**. It has tin dioxide (SnO$_2$) sensitive layer and Nickel-Chromium heater within micro-ceramic tube. Among 6 pins two connects heating coil and four for electrodes **[4]**. Mainly, MOS gas sensors have been used to assess pollutant in the ambient air. To assure accuracy and performance, gas sensor must be calibrated in proper way which is complex task. The calibration of MQ-2 gas sensor with standard calibration gas and apparatus is costly process. The previous work done on sensors only describes data generation by different sensors and calibration of sensors by using different methods **[5-7].** To simplify the process in economical way authors have calibrated MQ-2 sensor using Arduino Uno module. It is an open-source platform and makes easy debugging. Although the Arduino Integrated Development Environment (IDE) software is better at acquiring data, but lacking the tools that are suitable for storing and evaluating the data in real time. There are few softwares available for data acquisition through Arduino for real time data analysis **[8]**. PLX- DAQ is an open-source software **[9-10]**and in the present study it is used to import data to Microsoft Excel from Arduino. This system is an open-source for design and enable to acquire data from gas sensor in easy way. This system provides good solution to calibrate and analyze data in real time mode.

SYSTEM OVERVIEW
The system is developed with the combination of hardware and software. Hardware consists of Arduino Uno, MQ 2 gas sensor, homely gas samples and supportive components. While software includes Arduino IDE, PLX- DAQ to collect the data.

Arduino Uno
Arduino Uno is open-source hardware platform used to construct and program a device. It is controlled by ATmega328 having 14 digital I/O pins, where 6 pins utilized for PWM and other 6 for analog inputs. Additionally, it contains16-MHz crystal oscillator, a USB connection, a power jack and an In-Circuit Serial Programming header with an external power supply of 6V to 20V. The microcontroller ATmega328 has 32 KB of memory with 2 KB of SRAM, 1 Kilo bytes of Electrically Erasable Programmable Read Only Memory operates at 5 volts. Each pin can provide or receive 20 mA as a recommended operating condition. Due to its miniature size and capability to connect Wi-fi modules and GPS modules, Arduino Uno could be utilized as a central processor for air quality monitoring systems.

MQ-2 gas sensor
MQ sensors are most frequently utilized in applications because they are inexpensive, have a good lifespan, and have excellent sensitivity. MQ-2 sensor is used for detecting gases like LPG, hydrogen, propane, smoke, alcohol, etc. This proposed system is utilizing an MQ-2 sensor for calibrating the sensor for detecting smoke concentrations in homely gases.

Arduino IDE Software
To run Arduino Uno certain steps, have to be followed as:
1. Initially download the Integrated Development Environment software for Arduino. Run Windows Installer and follow the instructions displayed on the screen.
2. On connection to computer, appropriate Arduino driver is automatically fetched and Uno board is ready to use.
3. Start the Arduino application and select a suitable board. Follow the steps to select Arduino Uno / Atmega328 and appropriate serial port as COM3.
4. Upload program to the Uno board wait for a few seconds to examine the Tx and Rx LEDs on board for flashing. On successful upload notification displays "Done uploading". This enables Arduino to use.

PLX-DAQ Software
It is a software tool to import data into Microsoft Excel. It has particular format to transmit data on serial port of the device. Visual Basic Application macro is used to accept data on serial port then interpret and position it in the Microsoft Excel. The data will be displayed in the PLX-DAQ software.

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Hardware Integration

Fig. 1 show the circuit diagram of system with MQ-2 gas sensor module. This module has 4 pins V_{cc}, GND, D_0, and A_0 respectively. Which provides both analog and digital outputs. This module also has an in-built potentiometer to adjust the sensitivity of the digital output. A_0 pin of sensors module is attached to the A_0 of Arduino pin to get the analog inputs from the sensor. LCD 16 x 2, I2C module is used for display. Connect the I2C module pins SDA and SCL to the arduino after A_{ref} pin. USB cable is used to connect computer. IDE enables to data display on monitoring screen.

Flow Sequence

Fig. 2 shows flowchart, firstly initialize Arduino module and set the program code for gas concentration measurement. Compile and upload program code to Arduino. Expose the sensor to homely gases. Select the means of display. It could be LCD or the serial monitor. If it is selected as LCD display it would show ppm Concentration on its display. If PC monitor is selected PLX-DAQ software helps to analyze data in Excel sheet. Once it is done program ends.

Interfacing with PLX-DAQ Software

PLX-DAQ is interfaced through serial port to Arduino Uno. Fig.3 shows the real time data acquisition through MQ-2 sensor. PLX-DAQ accepts 26 coma separated values in Excel. This helps to perform real time analysis.

Experimental Set-up

Fig.4 shows setup used to carry out the study on gas concentration for homely gases. Arduino uno, MQ-2 sensor and LCD Display are integrated on bread board. To interface Arduino with Excel, the Sketch code is require as shown in Fig.5. This code enables to acquire data into spread sheet directly.

RESULTS AND DISCUSSION

The MQ-2 are resistive chemical gas sensor having small resistances. Because of current heating takes place which is used heat the air. Hence analog reading is obtained. In general, MQ-2 gas sensors required calibration before use to establish base value for clean air atmosphere. This value determines ppm level. As these sensors are non-linear thus required an accurate calibration. The interpretation of the sensor's raw analogue reading depends on calibration process. For this reason, gas sensors are calibrated and checked periodically to ensure sensor accuracy and system integrity. Standard procedures to calibrate gas sensor usually involve testing and recalibration process. There are different calibration methods and tools. Among them in this study 2-point calibration and 4-point calibration was selected for the response's analysis. The set up was prepared in house and tried to control environment.

2-point calibration

The gas sensor was calibrated setting the "Zero" reading and the Span. The Zero defines air atmosphere while the span defines a number of pre-mixed atmospheric gases. Fig.6 shows the two-point calibration graph of the MQ-2 gas sensor. Fig shows Zero reading in the clean atmosphere (when no sensitive gases are present). On the other hand, when sensor was exposed to smoke atmosphere it changes concentration level.

4-point calibration

The gas sensor was calibrated by the other method as setting "zero" at air and regulating the slop of three atmospheres with 3 different points. This kind of calibration grants a better accuracy compared to 2-point calibration. In the best Scenario the "zero" could be calibrated in the air while the other points required different pre-mixed atmospheres. Fig.7 shows the Four-point calibration response for MQ-2 gas sensor. It was observed that the clean atmosphere (when no sensitive gases are present) reading was zero. For three different conditions cigarette lighter, cigarette smoke, and pastile atmospheres were selected to study. In the different atmosphere's sensor response

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showed changes with respect to time. The response was measured for every two seconds span for all three atmospheres.

To determine the gas concentration standard datasheet of MQ-2 sensor was used. This datasheet provided the relation of (R_s/R_0) vs ppm. graph as shown in Fig.8. From the Fig 8, it is observed that resistance R_s of sensor depends on gas concentration. Known concentration in fresh air is considered R_0. The value of the R_s depends on average signals in form of voltage and it is obtained by below formula.

$R_s = [(V_{in} \times RL) / SV] – RL$ ----(1)

Where, V_{in} = input voltage of the sensor,

RL = Load Resistance,

SV = analog voltage reading from the sensor

According to MQ-2 datasheet, R_0 could be calculated as

$R_0 = R_s / 9.56$ ---- (2) (For fresh air)

As a first step, R_s is calculated in fresh air using equation (1). Later step with equation (2) calculates R_0. In the present study readings were taken from the MQ-2 sensor in the smoke environment. The internal parameters: sensor volt, R_s resistance, and R_s / R_0 ratio were obtained through Arduino programming. Table 1. shows the relationship between sensor voltage and sensor resistance ratio. It is observed that sensor voltage & resistance ratio are inversly related. It shows resistance ratio falls gradually with increasing concentration. To determine the Slope and y-intercept of the smoke line MQ-2 datasheet was used to extract data from the graph through Web plot digitizer. Fig. 9 shows graph's scale as log and hence ratio seems to be exponential with respect to gas concentration but actually it is not. For calculation, the lines were considered as linear.

$\log(y) = m * \log(x) + b$ -------(3)

where, $y = R_s / R_0$, x = ppm, m = slope of the smoke line
b = y - intercept of the smoke line
To extract the actual gas concentration inverse log of x is considered as:
$x(ppm) = 10^{\log(y)-b/m}$ ------ (4)

CONCLUSION

This paper describes the calibration methods for the MQ-2 gas sensor for air quality measurement at homely atmosphere by using Arduino Uno. In this study, the MQ-2 sensor is calibrated using 2-point and 4-point methods and obtained internal parameters such as sensor voltage, sensor resistance, and resistance ratio. With the log scale graph, concentration of gas is easily calculated. Thus, presented method of using Arduino could be used for any in-house developed gas sensor for calibration and real-time data acquisition.

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Table 1. Relationship between sensor voltage and resistance ratio

Sensor volt(mV)	R_s (Sensor resistance) in ohms	R_s / R_0 ratio
710	6.06	6.66
700	6.11	6.72
690	6.21	6.83
680	6.37	7.00
670	6.47	7.11
660	6.59	7.24
650	6.64	7.3

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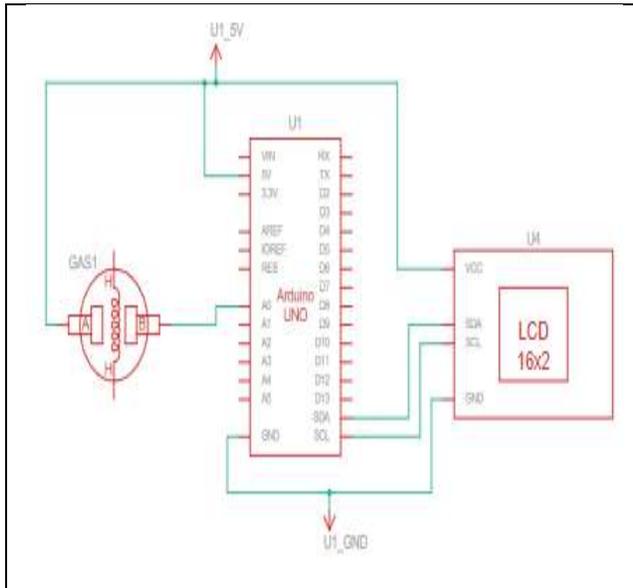
Fig.1: Connection diagram of Arduino Uno with MQ-2 sensor
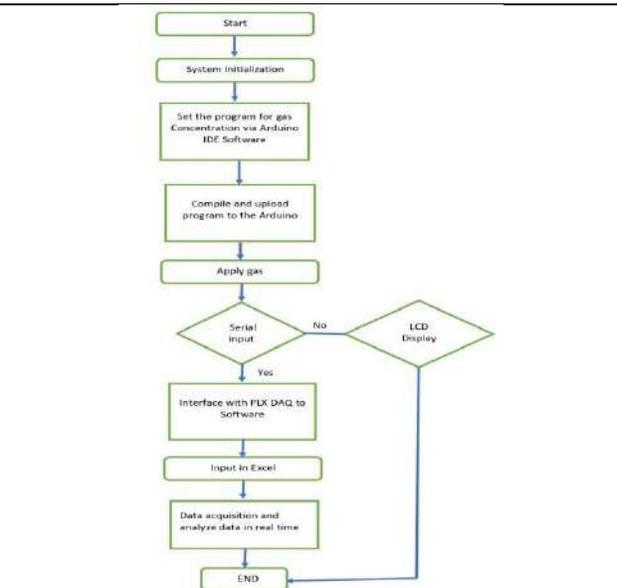
Fig. 2: The flowchart of gas detection and analysis
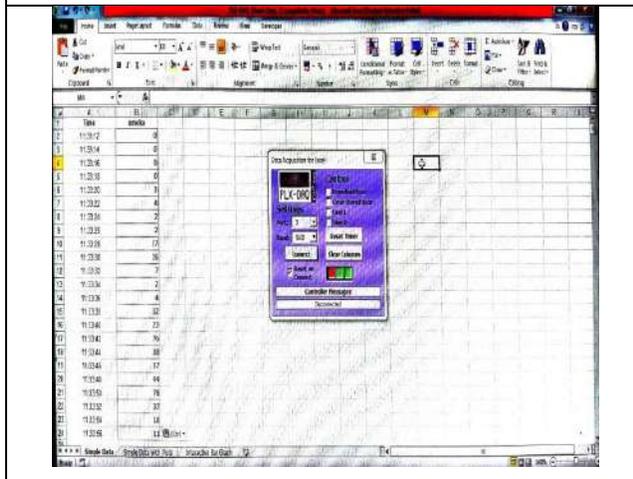
Fig.3: PLX – DAQ display Spreadsheet for MQ-2 sensor response
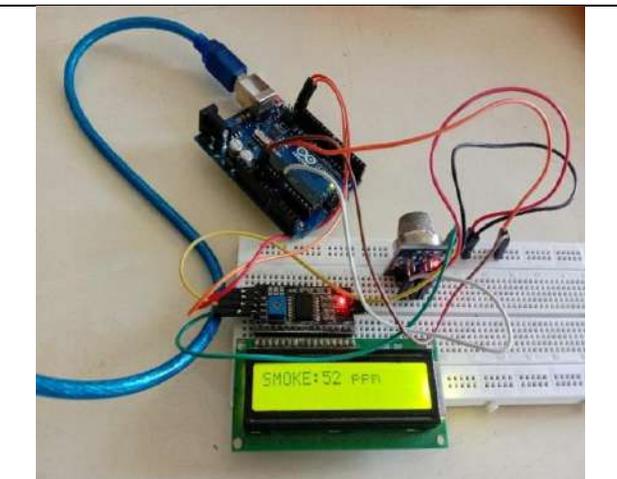
Fig.4: Arduino uno circuit connection and the status of the smoke level

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| **Fig.5: Arduino IDE sketch code for sending data to PLX-DAQ** | **Fig.6: Two-point calibration graph** |

| **Fig.7: Four-point calibration graph** | **Fig.8: MQ-2 sensor Datasheet ((Source: https:// www.nndigital. com/en/blog/2019/11/20/interfacing-mq-mq-2-smoke-gas-sensor-module-using-arduino-to-measure-combustible-gas-concentration/)** |
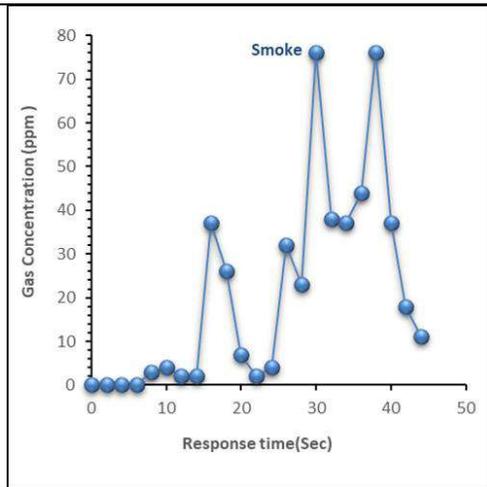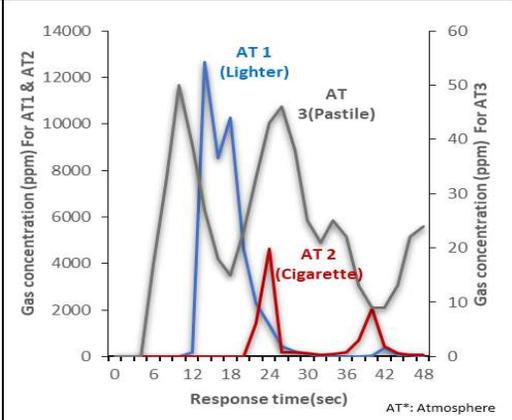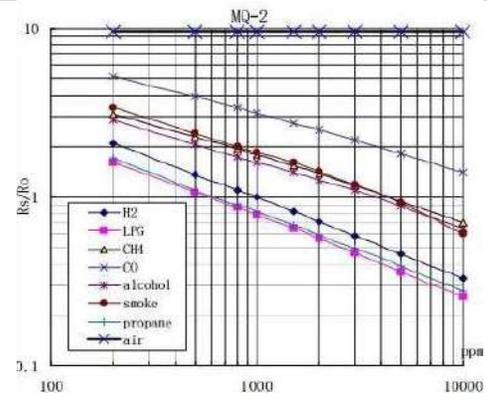
$$y = -0.65\ln(x) + 6.4486$$
$$R^2 = 0.9766$$
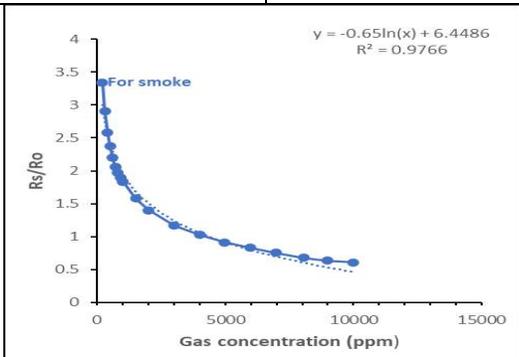
Fig. 9: Sensitivity characteristics of MQ-2 for smoke

RESEARCH ARTICLE

Evaluating Flood Risk in the Panam River Basin: A Comprehensive HEC-RAS Simulation for Hydraulic Analysis

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ABSTRACT

The utilization of hydraulic models in simulating floods is a widely adopted practice worldwide. This study specifically employed the HEC-RAS (1D) model to replicate diverse flood scenarios within the Panam River Basin, originating from the Panam Dam and converging with the Mahi River after a 22-kilometer course. The primary focus was computing water surface elevations within this basin while considering varying discharge scenarios. Through a series of simulations, inundation maps were generated for flood occurrences with return periods spanning 10, 20, 50, and 100 years. The objective was to analyze and identify flood-prone areas at different discharge levels. This assessment relied on time series data sourced from the dam, enabling the simulation of critical flood situations and their potential impacts on the Panam River Basin. To achieve this objective, a detailed study area model comprising 38 cross-sectional profiles was developed using the River Analysis System (HEC-RAS), a tool created by the US Army Corps of Engineers Hydrologic Engineering Center. This model allowed for an evaluation of flood conveyance performance, incorporating calculations for non-uniform flow. A meticulous calibration process was undertaken to enhance the model's accuracy in replicating water levels at various cross-sections along the river. The outcomes of our simulations indicated that Manning's roughness

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coefficient of 0.030 yielded the most precise predictions for the Panam River Basin. This research holds significance in providing crucial insights into hydraulic modeling, particularly in the context of assessing and managing flood risks within river basins. Ultimately, the findings contribute valuable knowledge essential for effective flood risk assessment and management strategies.

Keywords: Hydraulic modeling; Flood risk assessment; Panam River Basin; HEC-RAS, Inundation mapping; Discharge scenarios; Flood-prone areas; Flood simulation; Hydrologic modeling; River basin management.

INTRODUCTION

A vital aspect of flood control involves establishing an effective reservoir operation strategy with the goal of minimizing downstream river flooding. In countries like India, particularly in developing regions, there are notable challenges related to financial resources and infrastructure that present significant obstacles to improving irrigation system efficiency through physical upgrades. Historically, significant attention has been directed In the pursuit of enhancing the effectiveness of irrigation systems, particularly within the domain of tertiary-level water management. Hydraulic simulation models present a valuable tool for enhancing the operation and management of canals by providing insights into the flow dynamics within a canal network under various design and operational conditions. Mehta, D.J. [1] and Mohammed, J.R. [2] investigated the behavior of steady flow in the HEC-RAS software for forecasting discharge profiles and examining the correlation between head and discharge in river basins. Qasim [3] noted a tendency in HEC-RAS to overestimate water levels while underestimating them during low-flow periods. Islam, A. [4] introduced a hydraulic simulation model tailored to simulate both steady and unsteady flows in irrigation canal networks, encompassing branched or looped configurations and incorporating diverse flow control or regulation structures. The study also outlined testing outcomes to assess the numerical accuracy and stability of the model. Hydraulic modeling and flood simulation studies have been vital in understanding and managing flood risks in various river basins worldwide.

Numerous research efforts have explored the application of different modeling approaches to simulate and predict flood events accurately. Smith, A.B. et al. [6] highlighted the advancements in floodplain mapping by employing the HEC-RAS model, emphasizing its significance in delineating flood-prone areas with improved precision. This work showcased the model's capability in providing detailed flood hazard information essential for effective flood risk management strategies. In a comparative analysis conducted by Garcia, X.Y. & Patel, Z.K. [7], they explored the efficiency of employing both 1D and 2D HEC-RAS models to evaluate flood inundation scenarios. Their study highlighted the benefits of integrating both modeling approaches, showcasing how the combination of 1D and 2D models enhances the ability to comprehend intricate flood dynamics and provides more accurate predictions regarding the extent of flooding. Lee, Q.R. & Wang, L.M. [8] presented a comprehensive hydraulic modeling analysis focusing on a specific river basin's flood risk assessment using the HEC-RAS model. Their study provided valuable insights into utilizing the model for predicting potential flood occurrences and evaluating flood mitigation measures within the studied basin. Turner, P.S. & Nguyen, H.T. [9] made a significant contribution to the field by examining the calibration and validation procedures associated with the HEC-RAS model when applied to flood forecasting in smaller catchment areas. Their study highlighted the crucial role of precise model calibration in ensuring dependable flood predictions, particularly in regions prone to swift alterations in hydrological conditions.

Moreover, Wilson, K.J. & Gonzalez, M.L. [10] introduced an innovative approach by integrating remote sensing data into the HEC-RAS model for enhanced flood hazard mapping. Their study highlighted the potential of leveraging remote sensing technology to improve the accuracy of flood hazard assessments, particularly in data-scarce regions. Karamouz, Md. et al. [5] introduced an innovative methodology aimed at determining the most

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cost-effective combination of permanent and emergency flood control measures while optimizing crop patterns alongside a river. The optimization process hinges on flood control strategies identified by the model. Flood occurrences within a watershed cause significant damage across diverse land uses, often exacerbated by inadequate utilization of floodplain areas. One notable advantage of employing the hydrologic routing method lies in its seamless integration with the optimization model. Additionally, integrating a river hydraulic simulation model serves the purpose of establishing discharge-elevation and elevation-damage profiles for each section. These profiles are then integrated into the optimization model to assess flood-related damages, factoring in variables such as flood volume, floodplain zoning, land use within the floodplain, and economic costs associated with damaged areas per square meter, varying across different flood return periods.

Costabile, P. & Macchione, F. [11] made a significant contribution to the discourse surrounding numerical flood propagation within compound channels, specifically emphasizing the management of boundary conditions. Their research underscored the importance of system eigenvalues and lateral momentum transfer in the context of one-dimensional flood routing. They particularly highlighted the impact of disparities in Manning's coefficient values between the primary channel and its adjacent areas. As these discrepancies in flow velocities across the section increase, the extent of flooding on floodplains intensifies. The HEC-RAS 4.1.0 model, developed by the U.S. Army Corps of Engineers, is equipped with the capability to conduct three distinct types of computations: (1) steady flow analysis, (2) unsteady flow analysis, and (3) movable boundary flow analysis. In addressing steady flow, the model employs the standard step method to resolve gradually varied flow equations. For unsteady flow analysis, the model utilizes numerical methodologies to solve comprehensive equations governing gradually varied unsteady flow, often referred to as the dynamic wave method. The segment dedicated to movable boundaries relies on sediment continuity principles and utilizes various sediment transport equations to calculate variations in the riverbed elevation, encompassing both aggradation and degradation processes.

STUDY AREA

This research focuses on the Panam River Basin, which is part of the Mahi River Basin. The Panam River originates in the Devgadh Baria Taluka of the Dahod district and serves as a tributary to the Mahi River. Situated in the Santrampur Taluka of the Mahisagar district in Gujarat, the Panam Dam is positioned along the Panam River in India, approximately 25 kilometers upstream from where the Panam and Mahi rivers meet. The length of the Panam River from the Panam Dam to its confluence with the Mahi River spans approximately 21.77 kilometers. For conducting flow simulations via HEC-RAS, vital data related to channel geometry, boundary conditions, and channel resistance must be obtained. The study area covers an expanse of about 120 kilometers and is characterized by a mild slope. The impact of meandering was disregarded due to the absence of significant curvature within the study area.

HEC-RAS

In this current investigation, we utilized an unsteady, gradually varying flow simulation model known as HEC-RAS. HEC-RAS, short for the Hydrologic Engineering Center's River Analysis System, serves as a widely embraced software tool specifically designed for flood modeling and analysis purposes. Developed by the Hydrologic Engineering Center under the U.S. Army Corps of Engineers, this system, known as HEC-RAS, offers a comprehensive range of features and functionalities. It allows for the modeling of water temperature and quality and performs computations for one-dimensional steady flow, as well as one and two-dimensional unsteady flow. Additionally, the software assists in simulating movements of sediment and phenomena related to mobile beds. The Hydrologic Engineering Center has introduced the "Next Generation" (NexGen) of hydrologic engineering software, which includes the comprehensive HEC-RAS modeling system within its suite of tools. This advanced modeling system relies on finite difference solutions, as represented by the Saint-Venant equations. The application of this model was specifically employed to replicate a flood scenario within the Panam River Basin. HEC-RAS is a versatile tool that allows for the simulation of a wide range of flood scenarios, making it valuable for flood risk assessment, floodplain management, and emergency response planning. It is commonly used by engineers, hydrologists, and other professionals involved in flood modeling and management. Training and

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expertise in hydraulic modeling and the use of HEC-RAS are often required for effective flood analysis and inundation mapping.[14,15].

METHODOLOGY

The successful creation of the HEC-RAS model aimed to evaluate the susceptibility to flooding within the Panam River Basin. Usually, the process of one-dimensional flood modeling encompasses three primary phases, commencing with hydrological modeling followed by hydraulic modeling, and concludes with the analysis of flood levels and inundation extents. In cases where a catchment is gauged, observed stream flow data can be directly utilized as input for inflow and as an upstream boundary condition for hydraulic modeling. The hydraulic simulation predicts water levels based on the provided flow information, forming the basis for analyzing flood levels and potential inundation. The initial phase of hydraulic modeling within HEC-RAS focuses on data management. Real-world geographic features undergo translation into the model, employing GIS techniques such as spatial registration and geo referencing. The fundamental geometric data necessary for the hydraulic model includes cross-sectional information obtained from surveys and the extracted Digital Elevation Model (DEM). These components serve as the primary basis for running the hydraulic model.

Within the spatial layout, a network of rivers was established by linking 38 cross-sectional geometries, forming the basis for the hydraulic model. Specific Manning's roughness coefficients (known as "n values") were assigned to these river profiles. Manning's n signifies flow resistance and was determined following guidelines recommended by Chow [13]. For the 1D HEC-RAS model, Manning's n was set to a singular value for the channel and two distinct values for the floodplain. To accurately replicate historical events, unsteady flow data was incorporated into HEC-RAS as a boundary condition. In this study, stream flow data recorded during flood events between 1987 and 2017 were specifically utilized as the upstream boundary condition for the river model, while normal depth served as the downstream boundary condition. Ensuring synchronization between the simulation time in HEC-RAS and the provided flow data was essential. With all necessary inputs configured, HEC-RAS was poised to conduct hydrodynamic modeling. The final step involved initiating the unsteady flow model within the 'Run' window. Throughout the computational process, the 1D HEC-RAS model depicted the flow as unsteady, progressing downstream in a one-dimensional manner, using the provided cross-sections as a comprehensive representation of the river environment.

RESULTS AND DISCUSSION

In this analysis, we evaluate the adequacy of existing sections in light of twelve significant historical flood occurrences. Sections are categorized based on their criticality, determined by the depth of water above the existing bank. These categories include highly critical, moderately critical, and critical. Utilizing HEC-RAS software and historical flood data, computed sections are presented in figures. The map also features the numbered river cross-sections used in the hydraulic model, spanning from 1 to 38. Figure 3 illustrates the depth map of the Panam River Basin generated by the HEC-RAS model under various flood discharge scenarios. Figure 4 showcases the water surface profile of the Panam River Basin, simulated through the HEC-RAS model under diverse flood discharge scenarios. Figures 5 and 6 depict the river cross sections at the initial and final points of the Panam River Basin, respectively. Table 1 illustrates the critical sections determined for various flood discharges.

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CONCLUSION

It is highly recommended to raise the embankments or retaining walls at sections where water exceeds the existing levels. Installing flood gates at storm drain outlets is recommended to prevent floodwater from entering the study area. Given the sensitivity of certain sections to high floods, it is crucial to refrain from encroaching upon the width of the river, as any encroachment could lead to flooding in the study region. Additionally, it is strongly recommended to prohibit any new construction in floodplain areas.

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Table 1: Categorization of river cross section based on HEC RAS analysis.

Sr. No	Flood Events	Highly Critical Cross Sections	Moderately Critical Cross Sections	Critical Cross Sections
1	5 years return period(2684.646cumec)	CS-22	CS-20(R), CS-21	CS-13(L),CS-24(L), CS-31(L),CS-34(R) CS-20(L)
2	10 years return period (7039.022 cumec)	CS-21, CS-22	CS-13(L), CS-20(L), CS-31(L), CS-34(R)	CS-5 (R), CS-6 (R), CS-8 (R), CS-10(L), CS-12 (L),CS-15 (R), CS-12(R),CS-24 (L)
3	15 years return period (12546.009 cumec)	CS-20,CS-21,CS-22, CS- 31(L)	CS-8(R), CS-13(L), CS-23(L),CS-30(L), CS-34(R)	CS-5 (R), CS-6 (R), CS-17 (R), CS-9(L), CS-10 (L), CS-12(L), CS-15 (R),CS-16 (R), CS-18(R), CS-24 (L), CS-15 (32)
4	20 years return period (22361.394 cumec)	CS-8(R),CS-20, CS21,CS-22,CS 30(L),CS-31(L),CS-32(L),CS-34(R)	CS-12(L), CS-13(L), CS-18(R),CS-23,CS 29, CS-33, CS-35	CS-5, CS-6, CS-7(R), CS-9 (L), CS-10, CS-11(L), CS-15, CS-16 (R), CS-24(L), CS-25, CS-27, CS-28, CS-30(R), CS-31(R), CS-36, CS-38
5	25 yearsreturn period (39855.857cumec)	CS-7, CS-8, CS-20, CS-21,CS-22, CS-29, CS-30, CS-31, CS-32, CS-34(R)	CS-5, CS-6, CS-13(L), CS-16, CS-23, CS-28, CS-29,CS-33, CS-35, CS-36, CS-37	CS-9 (L), CS-10(L), CS-11(L), CS-12(L), CS-14(R),CS-15(L), CS-24(L), CS-25(L), CS-26(L), CS-27, CS-34(L), CS-38(R), CS-18(R)
6	30 yearsreturn period (50813.848cumec)	CS-7, CS-8, CS-20, CS-21,CS-22, CS-30, CS-31,CS-32,CS 33(L), CS-34(R)	CS-5,CS-6, CS-13(L), CS-23,CS-29,CS 33(R),CS-35,CS 36,CS-37	CS-9 (L), CS-10(L), CS-11(L),CS-12(L), CS-14(R),CS-15, CS-16, CS-18(R), CS-19, CS-24(L), CS-25(L), CS-26(L), CS-27, CS-34(L), CS-38
7	35 yearsreturn period (64784.636cumec)	CS-7, CS-8, CS-20, CS-21,CS-22, CS-30, CS-31,CS-32, CS-33, CS-34(R)	CS-5, CS-6, CS-13(L), CS-14(R),CS-15, CS-16, CS-23, CS-28,CS-29,CS-34(L), CS-35, CS-36, CS-37	CS-3(L), CS-9 (L), CS-10(L),CS-11(L), CS-12(L),CS-18(R), CS-19(R), CS-24, CS-25(L),CS-26(L), CS-27,CS-38
8	40 yearsreturn period	CS-7, CS-8, CS-20, CS-21,CS-22,	CS-5, CS-6, CS-	CS-2(L), CS-3 (L),

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	(82366.275cumec)	CS-23, CS-28,CS-29, CS-30, CS-31, CS-32,CS-33, CS-34(R)	11(L), CS-12(L), CS-13(L), CS-15,CS-16,CS-34(L),CS-35, CS-36, CS-37	CS-9(L), CS-10(L), CS-18(R), CS-19, CS-24, CS-25(L), CS-26(L), CS-27, CS-38
9	50 yearsreturn period (133884.188cumec)	CS-3, CS-5, CS-6, CS-7,CS-8, CS-9(L), CS-10(L),CS-11(L), CS-12(L),CS-13,CS-14, CS-15, CS-16, CS-20, CS-21, CS-22,CS-23,CS-28, CS-29, CS-30, CS-31, CS-32, CS-33, CS34, CS-35	CS-18(R), CS-26(L), CS-36, CS-37, CS-38	CS-1(L), CS-2(L), CS-19, CS-24, CS-25(L), CS-27
10	60 yearsreturn period (167390.777cumec)	CS-3, CS-5, CS-6, CS-7,CS-8, CS-9(L), CS-10(L),CS-11(L), CS-12(L), CS-13,CS-14, CS-15, CS-16, CS-20, CS-21, CS-22, CS-23,CS-28,CS-29, CS-30, CS-31, CS-32, CS-33, CS-34,CS-35, CS-36,CS-37	CS-1(L), CS-2(L), CS-18(R), CS-19, CS-26(L), CS-27, CS-38	CS-4, CS-9(R), CS-11(R), CS-12(R), CS-24, CS-25, CS-26(R)
11	75 years return period (235320.594 cumec)	CS-1(L),CS-2(L),CS-3,CS-4, CS-5, CS-6, CS-7,CS-8, CS-9, CS-10(L),CS-11, CS-12, CS-13, CS-14, CS-15, CS-16, CS-18(R), CS-20, CS-21, CS-22, CS-23, CS-26(L), CS-28, CS-29, CS-30, CS-31,CS-32, CS-33, CS-34, CS-35, CS-36, CS-37	CS-10(R), CS-19, CS-27	CS-1(R), CS-2(R), CS-24, CS-25, CS-26, CS-27
12	100 years return period (413609.575 cumec)	CS-1, CS-2, CS-3, CS-4,CS-5,CS-6, CS-7,CS-8,CS-9, CS-10, CS-11, CS-12,CS-13, CS-14, CS-15,CS-16, CS-18(R),CS-20,CS-21, CS-22, CS-23, CS-26,CS-28, CS-29, CS-30,CS-31, CS-32, CS-33, CS-34,CS-35, CS-36, CS-37, CS-38	CS-19, CS-24, CS-25, CS-27	

Figure 1. Study Area of Panam River Basin	Figure 2: Plotting of the river, Bank line, Flow Pathlines, and Cross Section in RAS Mapper
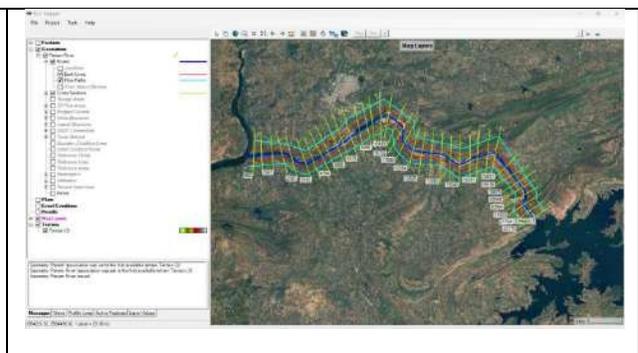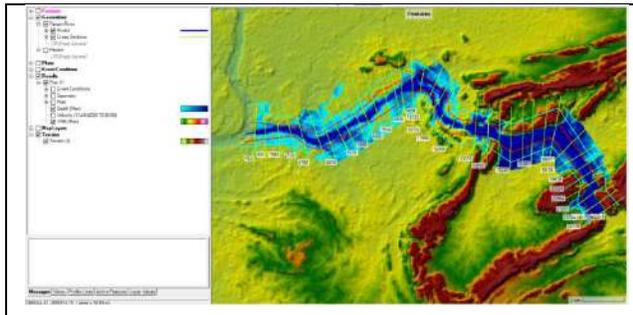
Figure 3: Depth Map Simulated in HEC RAS
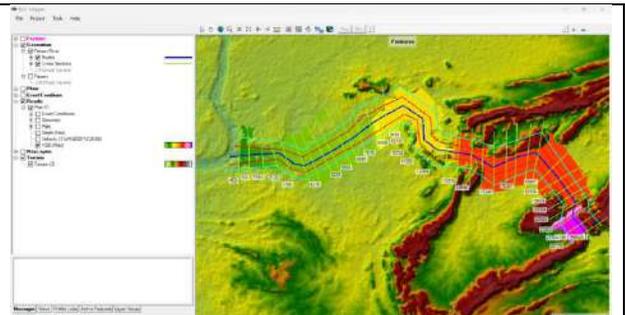
Figure 4: Water Surface Profile generated in HEC RAS
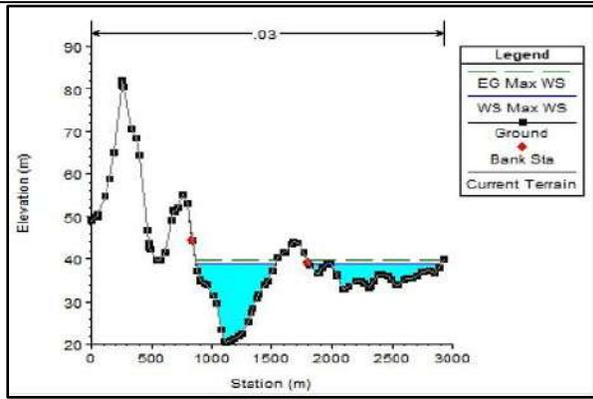
Figure 5. River Cross section at chainage 22175 m (At the begging of the River)
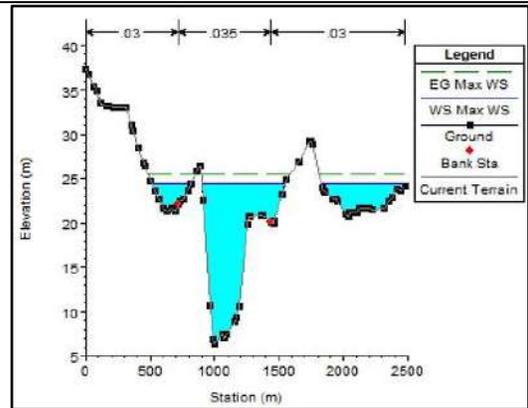
Figure 6. River Cross section at chainage 953 m (At the end of River)

RESEARCH ARTICLE

Pandemic Predictor Pro using Machine Learning Algorithms

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ABSTRACT

Technology advancement affects all element of life, whether it is in the medical field or any other profession. Artificial intelligence has shown promising results in the area of healthcare by using data analysis and processing to guide its decisions. The most important step in stopping the growth and spread of a life-threatening illness is early detection. The corona virus, which spreads fast from one person to another, is infecting more and more people. The medical community now has legitimate reasons to be concerned about the COVID-19 pandemic due to its rapid global spread, necessitating the development of an infection detection system. With the development of technology, we now have access to a multitude of COVID-19-related data that can be used to uncover important information about the infection. The approach with the highest accuracy was chosen for the model's final testing after we analyzed the COVID-19 prediction accuracy of various machine learning techniques.

Keywords: Index Terms - COVID-19, COVID-19 related symptoms, Logistic Regression, Decision Tree, Random Forest.

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INTRODUCTION

The whole country has come to a standstill because to the COVID-19 epidemic. From April 2020, severe acute respiratory syndrome corona virus 2 had infected over 2 180 000 individuals globally, caused more than 150 000 fatalities, and was initially identified by the World Health Organization as occurring in Wuhan, individual's Republic of China, on December 31, 2019. SARS-CoV-2 attacks cells in humans by using the angiotensin-converting enzyme 2 as cell receptors [1]. A long-lasting worldwide epidemic, large fatality rates, and weak medical systems are all characteristics of COVID-19. If somebody who is healthy comes into touch with an infected individual, the virus is disseminated through their lungs, according to the World Health Organization, which designated the epidemic as an emergency for public health. A person who is infected develops symptomatic within 2 to 14 days. Dry cough, weariness, and fever are listed by the World Health Organization as signs and indicators of moderate to severe diseases, whereas breathlessness, a high temperature, and exhaustion can happen in serious instances.

People who already have conditions like hyper tension, diabetes, or chronic lung disease are susceptible to contract the flu and run the risk of becoming very ill from it [2]. The only options for preventing contamination till vaccinations are readily accessible are instance solitude, contact tracking, incubation for possible infections, physical separation, disinfection, and sanitation precautions. People are being infected by the corona virus, which spreads quickly from one person to another [3], [4]. Medical experts and healthcare administrators are having difficulty diagnosing and treating sickness victims as well as controlling the spread of the illness. Rural places have a particularly sensitive spread risk. Lack of knowledge, poor nutrition, and, most significantly, inadequate public health centres, basic health centres, and district hospitals are some of the causes of this. Details on the spread of the disease must be made available to the public. They could use current technology in their attempts to stay current with knowledge regarding COVID-19 [5]. The fast spread of the influenza virus, that has killed hundreds of thousands of individuals, has necessitated the development of a technology that may be deployed to identify the infection. Technologies such as machine learning software, collection of data, and methods for classification are crucial for creating the COVID-19 prediction model. This research work is to evaluate the accuracy of various machine learning algorithms, such as Logistic Regression, Decision Tree, Random forest, and Naive Bayes, and subsequently use the best one among them to improve the impression of primary care for COVID-19, develop an effective system that predicts if or an individual has COVID with the information that is specified to the framework.

LITERATURE REVIEW

"Arogya as a sign of overall health and happiness." Today, humans must battle the revolutionary COVID-19 corona virus, an unseen enemy. It was first seen in Wuhan, China, and is currently rapidly spreading around the world. Singhal T. (2019), explored SARS-CoV-2 prompted corona virus illness, which triggered a first-time worldwide health catastrophe [6]. According to Sohrabi C. et al. (2019), observed that on 23rd of May 2020, the COVID-19 pandemic has already resulted in a total of 118,446 illnesses and 3,583 fatalities, with cases being documented in all states of India [7]. Zhu N., et al. (2019), Chakraborty I., et al. (2020) and Zhou P., et al. (2020) said that due to the high level of pre-existing exposure caused by insufficient healthcare systems and the shift of crucial health services for the place of committed treatment and supervision to suspected COVID-19 cases, the COVID-19 pandemic is thought to be posing significant challenges for medical care systems in developing countries. [8]-[10]. Lu R., et al. (2020) and Zu Z.Y., et al. (2020), proposed order to give care of individuals with mild to severe COVID-19 according to the selected medical guidelines, some secondary and tertiary care facilities in India that serve multitudes of every day outpatient services have temporarily been turned into specialized COVID-19 facilities [11], [12]. Aritra Ghosh, et al. (2020), observed COVID-19 illness in India around 1 lakh (0.1 million) infection instances by May 2020, and July 2020, there were 8 lakhs of instances total. Lockdown procedures and social segregation were used, which had negative impact on the country's finances, standard of being alive, and ecology. Where there appeared to be harm to the financial system and to people, there was perceived advantage to the planet [13]. Patrikar S., et al. (2020) explored, different

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methods of providing primary care models for the requirements for individuals with persistent illnesses and those related to maternity and child health. The overuse of routine booster services during the COVID-19 pandemic has led to an increased chance of epidemics of diseases that may be averted by vaccination returning, the WHO also cautioned[14]. Basu M. 2020 and Khanna R.C., et al. (2020) said that global awareness in primary healthcare centres assists in the early treatment of new communicable illnesses within communities with a reduction in the likelihood for mortality and illness. [15] [16]. Kumar A., (2020) seen in India, the rural regions, primary healthcare centres, which are the main and nethermost health stage, afford basic safeguarded, treatment, and maternity and infant medical care. They also provide critical medications alongside medical training. [17]. Countless of life might be saved by a reliable and thorough examination of COVID-19, which would also provide a wealth of data for training machine learning systems. In this context, ML can supply useful inputs, particularly for formulating diagnoses based on clinical literature, radiographic pictures, etc. Batista AFM, Miraglia JL, Donato THR, Chiavegatto Filho ADP (2020), evaluated that, the five ML algorithms such as SVM, NN, gradient boosted trees, random forests and logistic regression had comparable predicting efficiency and AUCs greater than 0.85 [18]. M. Rubaiyat Hossain Mondal, et al. (2020), determined 5644 samples from Hospital Israelita Albert Einstein of Brazil, it was here demonstrated that the classification of COVID-19 patients using multilayer perceptron (MLP), XG Boost, and logistic regression is accurate to over 91% [19]. David Goodman-Meza, et al. (2020) created and assessed a ML method for the diagnosis of corona virus illness based on lab characteristics and statistics approach was created. 1,455 ancillary laboratory characteristics get it from UCLA Health System in Los Angeles, California, it covered all ER and hospital cases undergoing SARS-CoV-2 PCR testing. The created method exhibited a 0.093 sensitivity and a 0.64 specificity [20].

METHODOLOGY

To detection of covid-19 using different sign and symptoms parameters from various machine learning algorithms and built models are used. The brief discussion is given below:

Data Collection
Researchers and hospitals have made information about the pandemic freely available since the WHO ordered it as a health emergency. We obtained a data set of 1418 cases from kaggle.com. This dataset includes one class property that determines if COVID-19 is detected and 16 factors are shown in table 1 that potentially influence the prediction of COVID-19 [21].

Data Pre-Processing
Preparing information is the process of transforming raw data into an understandable format. Real-world data, however, could be inappropriate for direct use in machine learning models since it might include noise, missing values, or come in an unworkable format. The crucial step of data pre-processing is cleaning that getting ready the data for machine learning models, which improves the precision and effectiveness of the models. The following are the crucial steps in data pre-processing:

Missing Value in the Dataset From fig. 1, checking if any missing value in dataset or not and also its data type.
Splitting the Dataset
Machine learning requires data preparation, which is includes the separation of the dataset into training and testing components. The dataset was divided, where 20% of the data kept for testing and the remaining 80% for training the model. Our objective to classify patients as either COVID positive or negative. To achieve this, we utilized all 16 independent variables in column x, with the dependent variable "COVID-19" in column y. Fig. 2 depicts the correlation between the dataset's independent and dependent features.

Method used
Predictive modelling is evolving along with the development of technology for computers. It is currently more effective and less expensive than it was in the past. In this study, several categorization methods were utilized to make predictions. Among the categorizing algorithms used are some of the following:

Logistic Regression
A machine learning-based method for data classification is logistic regression. This programme uses a logistic function to predict the probabilities of possible outcomes from one study. Logistic regression, which was created for this reason, is the most straightforward method for comprehending the impact of several independent variables on a single output variable. The algorithm determines the likelihood of falling into a specific class in overall and that are 0 or 1.

Decision Tree
In that features with values are located at vertices, limbs stand in for rules for decision making, and the leaves provide output or decisions, it may be described as a classifier with a tree structure. It generates a training model that used to predict the class or value of the target characteristics using simple decision guidelines derived from the training data. A decision tree has two vertices: decision and leaf. The leaf vertices are those decision vertices that make choices; decision vertices have numerous branches, but child nodes do not; moreover [22].

Random Forest
This classifier is a meta-estimator that uses the mean to expand the forecast execution of the system and reduce over-fitting. It responds to decision trees on the various portions of the information. This random forest classifier appears to be more accurate in most situations than decision trees, and it also reduces over fitting. The final feature importance is determined at the Random Forest level by the mean value across all trees. Numbers are computed and the average score of the feature's relevance for every tree is divided by the total number of trees.

Proposed Framework
The acquired data were examined, categorized, and the symptom and sign characteristics utilized to evaluate whether or not an individual is afflicted by the COVID-19 virus using an analytical framework developed utilizing a logistic regression, decision tree, and random forest classifier of machine learning. Individuals are shown the results, which helps the professional counsellor provide any extra healthcare services that may be required.

EXPERIMENTAL RESULTS

In order to assess the efficacy of the machine learning algorithms utilised in the present study, it was chosen to utilise the confusion matrix accuracy, mean squared error, precision, recall, and f1-score, which are generally used in fields like classification of binary data, machine learning, and data extraction.

$$\text{Accuracy} = TP + TN / (TP + TN + FP + FN) \tag{1}$$

Where, TP=True Positives
TN=True Negatives
FP=False Positives
FN= False Negatives

Precision
A measure of precision counts how many correctly positive forecasts have been estimated. It is determined by dividing the entire amount of properly anticipated positive instances by the ratio of correctly predicted instances that are positive.

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Precision = TP / (TP + FP)   (2)

Recall
Recall is resolute by dividing the entire amount of positive results by the sum of true positives and false negatives.

Recall= TP / (TP + FN)   (3)

F1-Score
Precision and recall may be combined into one metric using F1-Score, which covers both characteristics.

F1-Score = (2*Precision*Recall) /(Precision + Recall)   (4)

Confusion Matrix
The confusion matrix offers further information about a predictive model's efficiency, as well as which categories are successfully and mistakenly expected, and which kinds of errors are being produced. The ROC_AUC value, mean squared error, R^2 score, Accuracy score, precision, recall, and f-measure and confusion matrix for logistic regression is shown in fig. 5, decision tree in fig. 6 and random forest algorithm in fig. 7.

Receiver Operating Characteristic (ROC)
This graph contrasts the proportion of genuine positives to false positives. The expected accuracy increases as the graph moves closer to the axis. ROC-AUC-Score is the ROC curve's area under the curve. When a classifier is 100% accurate, it receives a score of 1, while a random classifier would receive a score of 0.5. In the dataset we were provided, the ROC-AUC-Score was 0.944713407, which is essentially worthless because it is so close to 1. It indicates that the models have provided a virtually perfect score [24]. The roc curve for logistic regression and decision tree are shown in fig. 8 and random forest in fig. 9. A comparison study was performed to assess the model's effectiveness. The findings demonstrate that the logistic regression, decision tree, random forest classifier are the best machine learning method, with an accuracy of 100% and a mean absolute error of 0.0%. This model's accuracy is superior to that of other models when compared, table 3 shown that comparison. The fig. 10 and fig. 11 shows COVID-19 Prediction Model accepts user input and produces result on the basis of COVID related symptoms and sign they are suffering from COVID- 19 or not. In terms of if individual having symptoms and sign related to Covid-19 then display message for positive one, else negative result.

CONCLUSION

The constructed model helps in determining whether a person has COVID-19or not based on their symptoms, rendering this study useful as a decision-supporting tool for physicians. It may also be employed by those experiencing symptoms associated with COVID-19 to determine whether they would test positive or negative for the virus. According to the signs they are experiencing, people may immediately identify whether they are at risk of spreading COVID-19. This result can be used by medical professionals as a primary health evaluation for COVID identification. It can also be helping in reducing direct contact with potential COVID-19 patients; more information or diagnoses from hospital data; individuals who got the virus; COVID-19 survives; individuals who are being evaluated or managed; all of these can be incorporated for future research. It is possible to use software that can forecast the extent of COVID-19 to offer more details on the actions that must be performed and the treatments that should be taken into consideration.

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Table 1. Sign and Symptoms as dataset Parameters

Dataset Parameters			
Breathing Problem	Fever	Dry Cough	Sore throat
Running Nose	Headache	Chronic Lung Disease	Heart Disease
Hyper Tension	Diabetes	Gastrointestinal	Fatigue
Abroad travel	Asthma	Contact with COVID Patient	Visited Public Exposed Places

Table 2. Confusion Matrix [23].

	Positive Prediction	Negative Prediction
Positive Prediction	True Positive (TP)	False Negative (FN)
Negative Prediction	False Positive (FP)	True Negative (TN)

Table 3. Comparison of Metrics for Logistic Regression, Decision Tree and Random Forest

	Accuracy Score (%)	Mean Squared Error (%)	R^2 Score (%)	ROC-AUC Value (%)
Logistic Regression	100%	0.0%	100%	100%
Decision Tree	100%	0.0%	100%	100%
Random Forest	100%	0.0%	100%	100%

Table 4. Comparison of Current Working Model With Other's

Author and Year	Techniques	Accuracy
M. Rubaiyat Hossain Mondal, et al., (2020)	Multilayer Perceptron (MLP), XGBoost and Logistic Regression	MLP, XGBoost LR= 91%.
Bhuvaneswar, et al., (2022)	KNN Logistic Regression Random Forest	KNN= 98.37% LR=97.03% RF= 98.39%
Current Research Work	Logistic Regression Decision Tree Random Forest	LR = DT = RF = 100%

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Fig. 1 checking for missing value of dataset.

Fig. 2 Correlation matrix of Covid-19 dataset
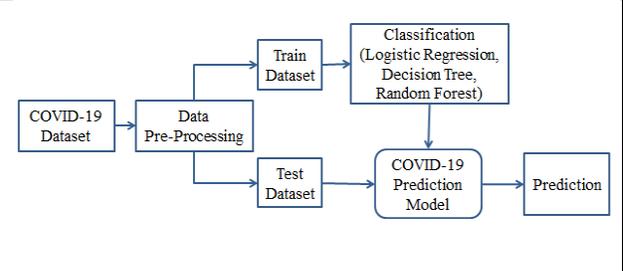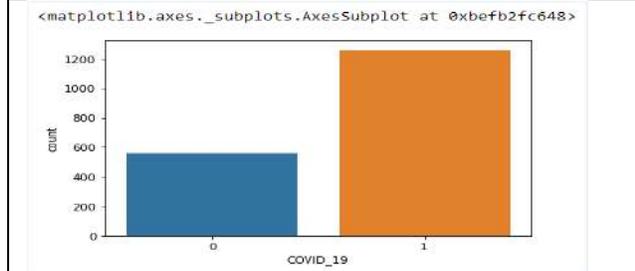
Fig. 3 No. of individuals infected with Covid-19 or not.

Fig. 4 Covid-19 Prediction Model
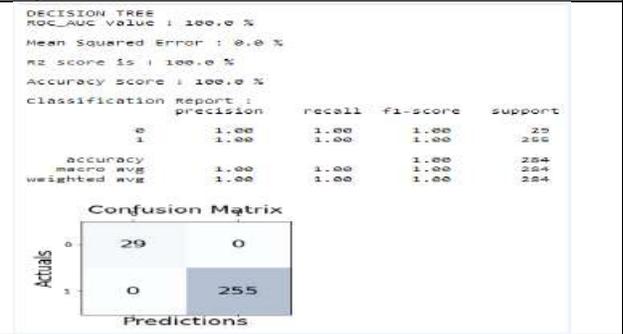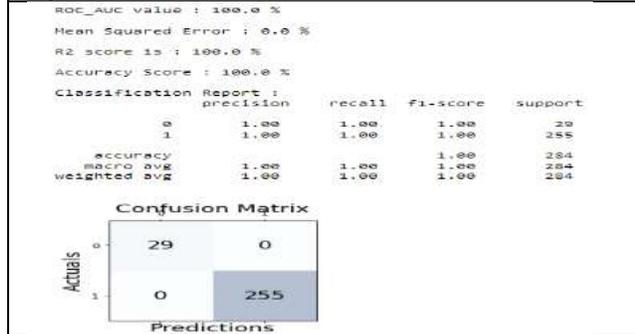
Fig. 5 Evaluation of Covid-19 Prediction using Logistic Regression

Fig. 6 Evaluation of Covid-19 Prediction using Decision Tree
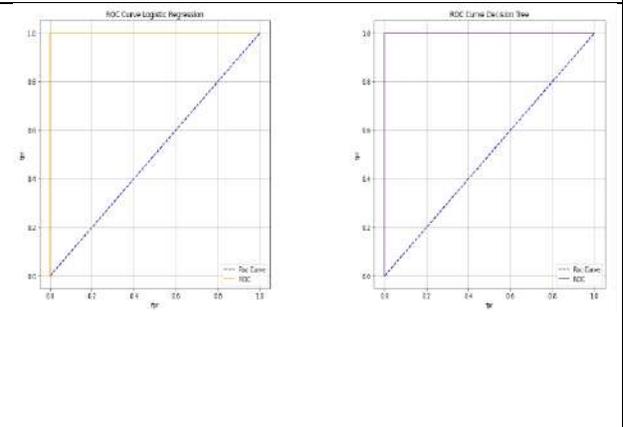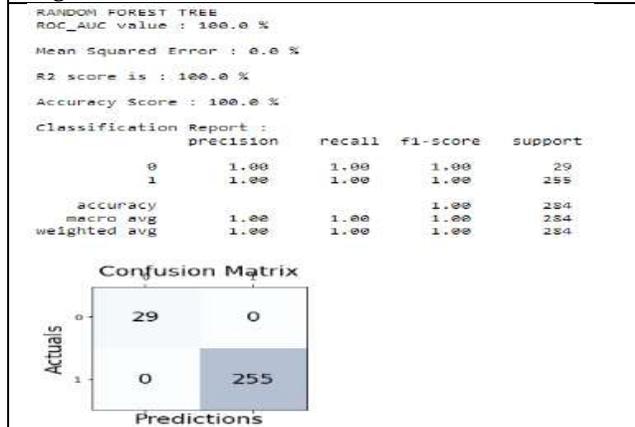
Fig. 7 Evaluation of Covid-19 Prediction using Random Forest

Fig. 8 ROC Curve for Logistic Regression and Decision Tree Algorithm

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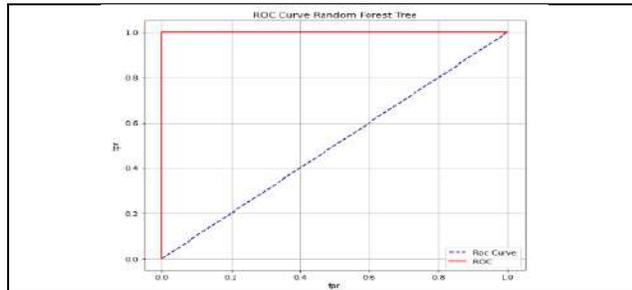
Fig. 9 ROC Curve for Random Forest Algorithm	**Fig. 10 Negative result prediction by COVID-19 Prediction Model**
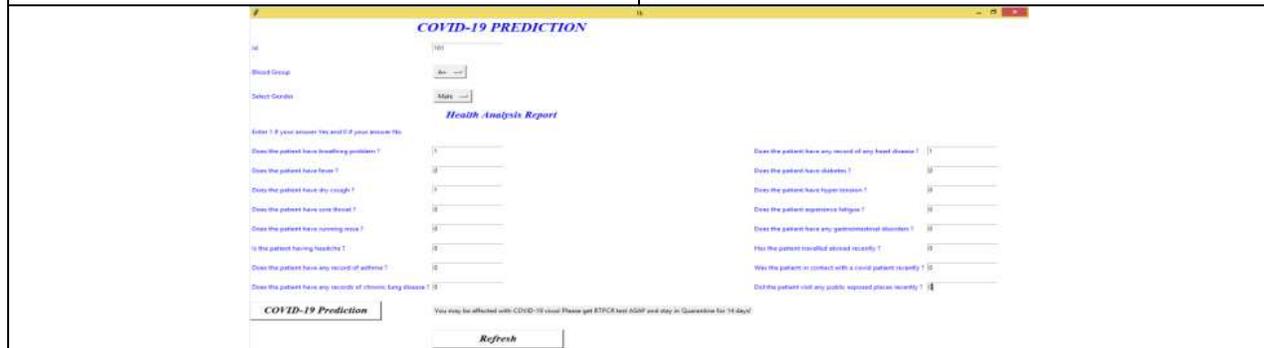
Fig. 11 Positive result prediction by COVID-19 Prediction Model

RESEARCH ARTICLE

Time Series Analysis of Precipitation for Uttarakhand Region

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ABSTRACT

Rainfall in Uttarakhand, is the main cause of the devastating landslides in Uttarakhand, Therefore, efficient rainfall monitoring is essential for managing hazards and evaluating ecosystems. The next-generation satellite mission that delivers global precipitation measurements is called Global Precipitation Measurement (GPM). For the areas of Uttarakhand from Jan 2000 to Dec 2022, we have extracted the monthly precipitation using the monthly GPM data that was available and extracted using Google Earth Engine for Uttarakhand region. Time series analysis was performed using available models in pycaret libraries. Theta Forecaster resulted with better results as compared to other time series model and resulted with rmse of 102.2861

Keywords*:* Rainfall, Precipitation, Time Series Forecasting, Google Earth Engine, pycaret, Global Precipitation measurement, Uttarakhand region, Theta Forecaster

INTRODUCTION

One of the key elements of water cycles is precipitation, which is essential for maintaining atmospheric equilibrium, promoting agricultural growth, and supplying fresh water. A shortage of precipitation can lead to drought and forest fires, while excessive precipitation can harm crops and produce floods, landslides, soil erosion, etc. [1] [2] Current advances in the area of big data and statellite has led to increased data influx which can be analyzed to enable better decision-making actions for any organization. One such type of data that occurs in abundance is the time series (TS) data. Analyzing and predicting time series data has been one of the toughest difficulties of modern-day data scientists and researchers. Google Earth Engine (GEE) provides a platform through which different statellite data sets can be accesed and used for desired needs [3] [4]. In this paper, NASA global precipitation [5] dataset is accesed

using GEE platform. The objective of the current study is to obtain precipiattion time series data provided by using Google Earth Engine and use python library PyCaret [6] to analyze the extracted time series data.

Time Series Definitions

Anything that is seen progressively across time may be categorized as a "time series." As an instance, sales patterns, the stock market, weather predictions, and so forth. In addition to numbers, labels, & colors, these observations maybe anything else. Additionally, the times at which the observation was made might be spaced regularly or sporadically. When it comes to time, however, it may either be discrete or continuous [7]. The time series approaches are founded on the concept that historical data has intrinsic trends which communicate important info for a future definition of the researched phenomenon. One of the fundamental purposes of time series processing is to detect these trends: the conditions under which the patterns observed will be repeated, and the modifications they could experience throughout time [8]. The major aim of TS predicting is to capture patterns in data & model them accordingly. The prototype can then be used to extrapolate and acquire reliable forecasts for any application. A good model always tries to fit data as precisely as probable with the least error without loss of generality. It is possible to think of TS data as a collection of data points that show changes over time. As a set of vectors X(t); t = 0, 1, 2,...n, it may be described as follows: The time series is said to be uni variate if the number of parameters changing concerning time is one. If the number of parameters is more than one then it is termed as multivariate time series data [9].

Time series forecasting components

Any time series will have the following four components [9] [10]

Trend This component affects the overall movement of an average of the data across time series. Examples include variations of house rents concerning time.

Cyclic This component describes the medium-term cyclic changes in data. Examples include economic and financial data

Seasonal This component occurs when there is a pattern across time series at a repeated interval. Examples include a variety of temperatures across the year.

Irregular This component contributes to randomness in the time series data. Real-life ex. Include war, strikes, disasters.

LITERATURE REVIEW

On-time series forecasting, this literature review examines previous and current studies. we will discuss the general progress which has been made in the area of TS predicting up to this point. we will discuss the research that has been done and the methods that have been employed in the study. We'll also talk about methods that have been utilized to create time series models here. [11]One of the most important parts of the hydrologic cycle, precipitation has long been used as a starting point for understanding how climate change works. In order to improve the understanding of the hydrological situation of the research region in Northern Greece within the prefecture of Pieri, this. work's goal was to look into the temporal variability of precipitation [12]SPI and SPEI were evaluated in this study to identify droughts. While SPEI uses a water balance based on the difference between evapotranspiration and precipitation, SPI is a precipitation-based indicator. Both indices were able to recognise the temporal variability of droughts and the various types of droughts as indicated by the various timelines. [13] Authors found that in order to enable accurate and unbiased monitoring of vegetation phenology in a consistent, timely, and cost-effective manner, satellite remote sensing measurements offer a significant potential for characterising spatiotemporal patterns of vegetation phenology at all scales, from local to global. Measures of general vegetation phenology as well as species-specific vegetation phenology (such as blooming and silking phases) are included in vegetation phenology monitoring. Authors extracted data of the twenty administrative areas of Italy, we evaluated the trend and seasonal components of the monthly precipitation time series in this study. Using the Mann-Kendall test, we discovered that the only months with a downward trend in precipitation for both northern and southern areas were April, September, and December.

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RESEARCH METHODOLOGY

This section contains the description of the problem identification as well as the proposed methodology to perform the sentiment analysis on the selected dataset. Precipitation Time series dataset was collected for uttarakhand region using GEE. Figure 1 shows study area uttarakhand and its precipitation data as median for the period from Jan,2000 to Dec,2022 Collected data is preprocessed and time series components were extracted.Availabe forecasting methods in PyCaret library were applied and result of RMSE metric is choosen for forecasting.Figure 2 shows the methodology used for time series data collection and time series analysis.

RESULTS AND DISCUSSION

Description of the monthly precipitation dataset for Uttarakhand region, as well as its visualization, are included in this section, as well as discusses the analysis of experiments performed in the current research work. Figure1 shows monthly Precipitation data for Uttarakhand. The monthly precipitation time series data for the Uttarakhand region is divided into three components: a linear trend, a periodic (seasonal) component, and random residuals. The trend shows an upward trend and the seasonality will repeat itself in a year. Figure 4 shows Seasonal Decomposition of Monthly precipitation time series dataset for Uttarakhand. Monthly precipitation time series dataset for Uttarakhand region is decomposed into three components: the linear trend, the periodic (seasonal) component, and random residuals. Trend shows an increasing trend and seasonality is repeating after 1 year. Pycaret library is used to apply time series forecasting as the library package enables the use and comparison of several models at once. Table 1 shows the results of time series forecasting models applied in descending order of metric SMAPE along with other metrics used to measure accuracy of a model. Theta Forecaster model performs well with SAMPE of 0.5049

CONCLUSION

In this paper, we estimate the monthly precipitation trend and seasonal components Time series of the Uttrakhand State. The amount of time series data produced is growing exponentially every day. Using time series analysis helps various decision makers keep their policies accurate and enables better decisions. This article provides a method for acquiring time series data using the Google Earth engine and implementing time series models using the pycaret library. This study shows that the total rainfall in Uttarakhand is increasing. These models, which take into account other parameters such as temperature, soil moisture and wind, can provide results better and more reliable forecasting results. We hope that the results can help decision makers and stakeholders to develop appropriate risk management strategies to maintain sustainability. to the environment.

FUTURE SCOPE
The methodology used in this study to analyze precipitation time series data of Uttarakhand region can be applied to other area of interest and with spatial time series data set. Other prevailing libraries for time series analysis can be explored and tested with the current data set and other spatial data set. The Precipitation data extracted using Google earth Engine for Uttrakhand region can also be verified using ground truth (refers to the data collected 'on site', on surface of the Earth regarding characteristics of the Earth surface features.) value for different sations monitoring rainfall/Precepitation data in Uttrakhand.

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S.N.	Model	MASE	RMSSE	MAE	RMSE	MAPE	SMAPE	R2	Time Taken (Sec)
1	Theta Forecaster	0.647	0.594	73.5454	102.286	0.9298	0.5049	0.8231	0.0533
2	Exponential Smoothing	0.829	0.767	94.1764	131.05	1.0458	0.5431	0.681	0.1167
3	Seasonal Naive Forecaster	0.87	0.8307	98.8452	142.271	1.0675	0.6079	0.6499	0.1833
4	Auto ARIMA	0.697	0.6185	79.1439	106.414	1.2438	0.5516	0.8086	19.28
5	ARIMA	0.909	0.8607	103.244	147.262	1.2563	0.6142	0.6194	0.2433
6	ETS	1.653	1.7248	187.561	298.555	1.3365	0.8662	-0.827	0.7867
7	K Neighbors w/ Cond. Deseasonalize & Detrending	0.732	0.6311	83.1566	108.624	1.3851	0.6412	0.8005	2.28
8	Extra Trees w/ Cond. Deseasonalize & Detrending	0.692	0.6236	78.6846	107.429	1.408	0.5354	0.8041	2.78
9	Random Forest w/ Cond. Deseasonalize & Detrending	0.703	0.6223	79.9595	107.233	1.4165	0.5595	0.8053	1.9167
10	Light Gradient Boosting w/ Cond. Deseasonalize &	0.728	0.6442	83.0423	111.249	1.4792	0.5923	0.7879	1.68

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	Detrending								
11	Gradient Boosting w/ Cond. Deseasonalize & Detrending	0.733	0.6487	83.5054	111.859	1.5019	0.6182	0.7868	1.1433
12	Extreme Gradient Boosting w/ Cond. Deseasonalize & Detrending	0.811	0.7228	92.3124	124.349	1.5996	0.5905	0.7372	1.9433
13	AdaBoost w/ Cond. Deseasonalize & Detrending	0.717	0.624	81.4879	107.461	1.6939	0.5793	0.8047	1.2633
14	Huber w/ Cond. Deseasonalize & Detrending	0.736	0.6481	83.8221	111.609	1.787	0.5823	0.7883	1.0933
15	Bayesian Ridge w/ Cond. Deseasonalize & Detrending	0.748	0.6504	85.1114	112.046	1.8806	0.5772	0.7869	1.41
16	Orthogonal Matching Pursuit w/ Cond. Deseasonalize & Detrending	0.751	0.6354	85.3882	109.441	1.999	0.5901	0.7969	1.0833
17	Lasso Least Angular Regressor w/ Cond. Deseasonalize & Detrending	0.763	0.6721	86.8548	115.72	2.0035	0.5846	0.7722	1.64
18	Elastic Net w/ Cond. Deseasonalize & Detrending	0.763	0.6721	86.8547	115.721	2.0035	0.5846	0.7722	1.3433
19	Lasso w/ Cond. Deseasonalize & Detrending	0.763	0.6721	86.8548	115.72	2.0035	0.5846	0.7722	1.06
20	Ridge w/ Cond. Deseasonalize & Detrending	0.763	0.6721	86.855	115.723	2.0036	0.5846	0.7722	1.0533
21	Linear w/ Cond. Deseasonalize & Detrending	0.763	0.6721	86.855	115.723	2.0036	0.5846	0.7722	1.8667
22	Decision Tree w/ Cond. Deseasonalize & Detrending	0.943	0.8107	107.632	140.448	3.8181	0.7138	0.655	1.0633
23	STLF	1.234	1.0062	140.495	172.799	4.1136	0.8833	0.4896	0.0733
24	Grand Means Forecaster	1.703	1.406	193.44	242.282	6.6071	0.9122	-0.001	0.0833
25	Polynomial Trend Forecaster	1.895	1.4368	215.286	247.607	8.1868	0.9548	-0.045	0.0533

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| 26 | Croston | 2.01 | 1.4919 | 228.27 | 256.809 | 8.7869 | 0.9705 | -0.119 | 0.03 |
| 27 | Naive Forecaster | 4.653 | 3.3067 | 528.377 | 566.31 | 21.53 | 1.2122 | -4.533 | 2.053 |
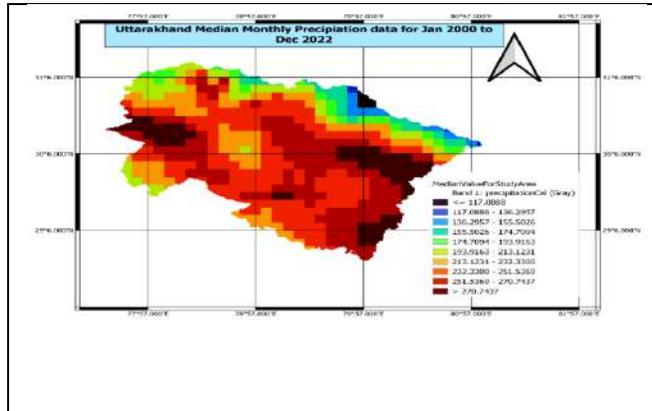
Fig. 1. Uttarakhand Precipitation median data for the period from Jan,2000 to Dec, 2022
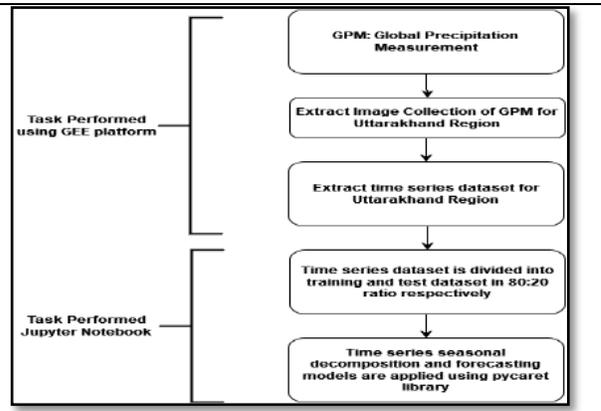
Fig. 2. Methodology
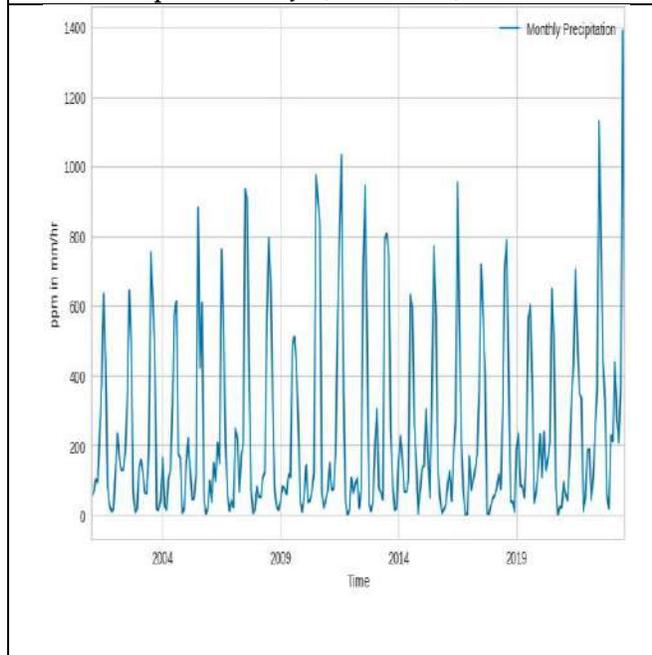
Fig. 3. Monthly Precipitation data for Uttarakhand
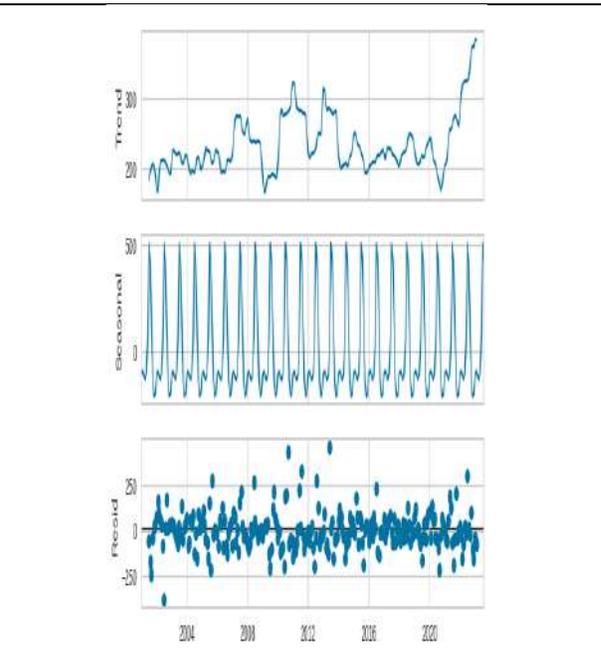
Fig. 4. Seasonal Decomposition of Monthly precipitation time series dataset for Uttarakhand

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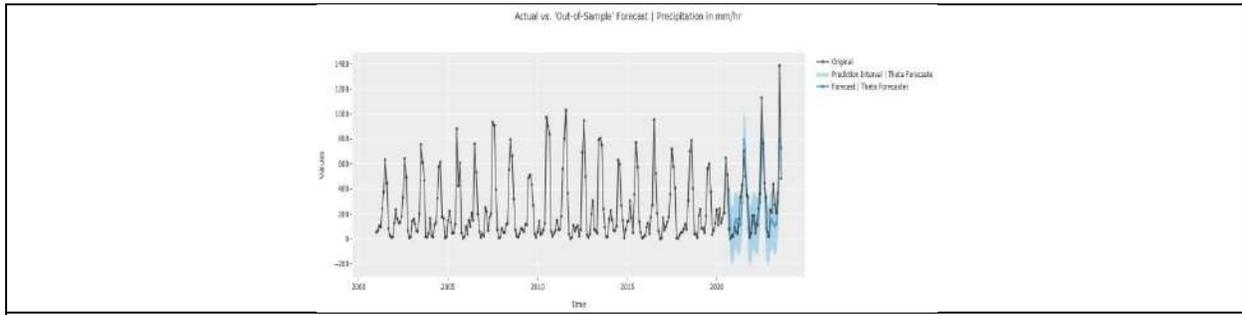
Fig. 5. Theta forecast model applied to test data

RESEARCH ARTICLE

Potability Testing of Drinking Water from Trains on Konkan Railway Route

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ABSTRACT

The availability of drinking water is one of the primary passenger amenities provided by the railways. The present study was undertaken to investigate and evaluate the water quality of the trains plying on the Konkan railway route. The physicochemical and microbiological studies were carried out to determine the potability of water supplied by railways. The isolation and phenotypic characterization of various pathogens were mainly emphasized. All the analyzed samples showed the presence of coliforms and other organisms indicative of fecal contamination. Seasonal analysis of microbial load indicated that monsoon favours the growth and proliferation of microbes. The biochemical assessment showed the presence of several pathogens like *E. coli, Salmonella spp., Vibrio spp., and Clostridium spp.* This is a matter of public health concern to train commuters which in turn calls for better sanitary measures.

Keywords: Water quality, Potability Testing, Train Water, Waterborne Disease, Coliforms

INTRODUCTION

Availability of drinking water is one of the primary passenger amenities provided by the railways. Constant efforts are made to meet the water demands of passengers by providing drinking water taps throughout the length of the platform. Additionally, water is provided in the taps inside the toilet and sinks in different coaches of the train. Indian railways also ensure the quality of the supplied water, for which full-fledged guidelines are defined. However, numerous studies states that the water that lines the train network is not fit for human consumption [1]. The Bureau of Indian Standards (BIS) calls for zero bacteria in drinking water. A recent study indicates dangerously high bacteria levels in the station water system [2]. Nevertheless, another study found that the water at the station is highly contaminated with coliforms [3]. Another report released by NDTV India revealed that 100% of the samples analyzed in the Lucknow division were reportedly contaminated with coliform bacteria. Konkan Railway connects the states of Maharashtra, Goa, and Karnataka in India and serves as a lifeline for thousands of people traveling through this route. Station halts provide a source of drinking water for commuters. A shocking revelation from news

updates, previous studies, and analysis of different stations has stated that the supplied water is non-potable and hazardous to health. Goa is a part of the Konkan region, and many people use the rail route to travel to workplaces, schools, and vacations destinations. Not much study has been done to monitor the quality of drinking water supplied in Konkan railways. Hence, this study analyzes the water quality supplied at Madgaon station and different trains plying on the Konkan railway route.

MATERIALS AND METHODS

Sampling
Samples were aseptically collected during monsoon and post-monsoon seasons in clean sterile bottles from the A.C and sleeper coaches of 6 different trains plying on the Konkan route namely – Konkan Kanya Express (10112), Maru Sagar Express (12977), Bhavnagar Kochiveli Express (19260), Gandhidham Express (16336), Okha Express (16338), and Nizamuddin Express (22633). Water samples from the train refilling sites and drinking water taps along the platform on Madgaon Railway station were also collected. Samples were collected from random coaches of a train which were then pooled together to obtain a collective sample (500 ml) of that train. A total of 48 such samples were collected from different trains and analyzed during monsoon and post-monsoon seasons. A total of 16 different samples of refilling sites and drinking water taps were also collected and analyzed. Approximately 50 ml of each sample was taken separately in a clean beaker and the physico-chemical analysis was carried out on site of all the samples. The remaining samples were then transported to the laboratory in ice for further microbiological analysis [4].

Physico-chemical analysis of water samples
Physico-chemical characterization of the water samples was carried out on-site by analyzing the following parameters: - Temperature, pH, odor, and turbidity.

Microbiological assessment of water samples
Standard Plate Count (SPC) of the water samples was carried out using Nutrient agar and incubating at 37^0C for 24 hours. The Coliform count of the samples was determined by the MPN method using McCrady's statistical probability values [4]. Potability of water samples was determined by presumptive, completed, and confirmed tests [5]. Isolation of pathogens like *E. coli, Vibrio, Salmonella, Shigella, Streptococci* and *Clostridium* was carried out using Eosin-methylene blue (EMB), Endo agar, Bismuth Sulfite agar, Deoxycholate Citrate agar, Sodium azide Lactose broth and Litmus milk over layed with paraffin oil respectively, after inoculating the samples in enrichment broths [6, 7, 8]. Different colonies of organisms obtained on various selective media were picked up and preserved on Nutrient Agar slants for further testing. Further, the Gram character and phenotypic characters of the isolates were determined. Phenotypic characterization and identification of the isolated pathogenic organisms were carried out via several biochemical tests using Bergey's Manual of Determinative Bacteriology [9, 10].

RESULTS AND DISCUSSION

A total of 6 trains were chosen for sampling, plying on the Konkan railway route, namely Konkankanya Express (10112), Maru-Sagar Express (12977), Bhavnagar Kochuveli Express (19266), Gandhidham Express (16336), Okha Express (16338), and Nizamuddin Express (22633). Sampling was done on both the Sleeper coach and A.C. coach. Two source sites were also chosen for sampling - the refilling site and station taps found on the platforms. Sampling was carried out at Margao railway station. A total of 64 water samples were collected and analyzed, including 2 samples per source per season (Phase 1 & Phase 2).

Physico-chemical analysis of water samples
Physico-chemical parameters, namely temperature, pH, odor, and turbidity for all the samples, were determined on-site. The temperature of the water samples varied from 23^0C to 27^0C during Monsoon and post-monsoon season. The

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standard pH for drinking water is between pH 6.5 to pH 8.5, as recommended by WHO as a guideline value [11, 12]. The pH of the water samples varied between pH 6.5 to pH 8.0 during the Monsoon and post-monsoon seasons. This finding indicated that the pH values of all the water samples analyzed lie within the permissible range. Turbidity is due to the presence of suspended particulate matter such as clay or slits, organic matter, plankton, or other microscopic organisms [13]. Most of the water samples analyzed were clear and odorless during both Monsoon and Post-Monsoon seasons except for a good number of samples (Monsoon) that were turbid. A few samples of Post-Monsoon season had a rusty odour which may be due to the rusty pipelines.

Microbiological assessment of water samples
Standard Plate Count (SPC)

The SPC of all the water samples from different trains, including the two source sites was determined. It was observed that during the Monsoon season, the SPC of the Sleeper coach was much higher than that of the A.C. coach of the trains. SPC performed during the Post-Monsoon season showed a similar result, i.e., the Sleeper coach had a higher SPC value than the A.C coach. A comparison of SPC values of the Sleeper coaches of different trains was carried out between the Monsoon and Post-Monsoon, and we saw that the load was higher in the Monsoon season as compared to the Post-Monsoon season. A similar comparison was carried out for A.C. coaches, revealing approximately the same type of results. The refilling site had a higher SPC value than the station tap water during the monsoon and post-monsoon seasons. Probably the station tap water might have been treated before being released into these taps.

Most Probable Number (MPN)

The MPN technique determines the total number of coliforms present in the water sample by observing acid and gas production by coliforms in multiple tubes of MacConkey's broth [1]. All the train water samples showed the presence of coliforms, the number is highest in the water samples from the Konkankanya Express (>1800MPN/100ml) and Gandhidham Express (>1800MPN/100ml) compared to others during the Monsoon season. A decrease in the MPN values was observed during the Post-Monsoon season (Fig 2 (a, b)). A study conducted on central railway stations of Mumbai suburbs showed a similar result, with Thane station water having the highest MPN value (>1800MPN/100ml) [1]. During the Monsoon and Post-Monsoon seasons, water samples collected from the Refilling site showed a higher MPN value than the Station Taps (Fig 1). According to WHO standards, the number of coliforms per 100ml of the sample should not be more than 10 [11]. The water samples from different trains and the Refilling site showed MPN values higher than the WHO standard, indicating that they were not suitable for consumption. The MPN values of the water samples collected from the Station Taps were between the permissible values.

Isolation and Identification of Pathogens from water samples

In addition to SPC and MPN, Potability checks of all the water samples were carried out, including Presumptive, Confirmed, and completed tests. We observed that the rest of the samples were unfit for human consumption except for Station Tap waters. This result calls for an urgent need for the railway authorities to investigate the matter and do the needful. This finding is of utmost significance to the overall health of travelers since a large section of people use rail as their means of transport. Phenotypic characterization of the bacterial isolates obtained was carried out, including Gram staining and Biochemical tests. The results indicated a high incidence of pathogens like *E. coli, Salmonella, Shigella, Vibrio, Clostridium*, and *Streptococcus spp.* Every water sample collected from the trains showed positive results for *E. coli*, the indicator of fecal pollution accompanied by *Salmonella* spp. and *Shigella* spp. Surprisingly *E. coli* was present in each of the 56 samples analyzed (Fig 3).

This outcome indicates that there was fecal contamination in these drinking water samples. A recent study obtained similar results in drinking water at Central Railway stations of Mumbai suburbs [1]. *Salmonella* was isolated only in train water samples but not in refilling sites and station tap water samples. Probably, *Salmonella* contamination may be originating from the pipe connecting the Refilling site to the train supply. However, *Shigella* was detected in the Refilling site and the train water samples but not in the Station Tap water. The presence of *Shigella* is obvious as it has been detected in the source. Still, the absence of *Shigella* in Station Tap waters may be attributed to the treatment of

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water before being released into these taps. *Vibrio* was not found in the Refilling site and Station tap water but was present in train water samples, indicating their entry into the pipeline beyond the Refilling site. *E. coli* was found to be predominantly present in water samples during both seasons. There was not much difference in the incidence of *Salmonella* and *Shigella* in both seasons. In line with our findings, *Salmonella typhimurium* was detected in water samples from the Thane station only during the monsoon season. [1]. Additionally, the incidence of *Vibrio, Streptococcus fecalis*, and *Clostridium* in train water samples was exceptionally high in Monsoon compared to Post-Monsoon. Season-wise testing of all water samples showed that monsoon season was more favorable than post-monsoon season for microbes to grow and flourish. Therefore, these pathogens pose a hazard to human health and especially to train commuters who comprise a diverse population ranging from the very young to the very old and inclusive of susceptible and immune compromised individuals. The study suggests the need for stringent testing and treatment of these public sources of drinking water which is consumed by a humongous population of travellers.

CONCLUSION

Konkan Railway is one of the zones of the Indian Railways connecting the states of Maharashtra, Goa, and Karnataka in India. The availability of safe drinking water is one of the primary passenger amenities provided by the railways. Constant efforts are made to meet the water demands of passengers within the halt period of the train by providing drinking water taps along the length of the platforms. So also, water is available in taps of toilets and sinks in the different coaches of the train. However, our study shows a discrete microbial population in the water supplied by trains and at Madgaon station. In addition, we also found the presence of various pathogenic organisms which pose a significant threat to the health of commuters. Our study shows that the water available for travelers is unfit for human consumption and could be the main reason for future waterborne disease outbreaks. Millions of people use the train as their means of transport in everyday life. The findings call for strict surveillance of water standards supplied to passengers by regulatory agencies. Moreover, stringent monitoring and implementation of quality standard rules must be adhered to as water can act as a passive carrier for various diseases.

ACKNOWLEDGEMENT

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Table 1. Sampling schedule

Seasons	During Monsoon		Post Monsoon	
Sampling No.	Phase 1	Phase 2	Phase 1	Phase 2
Month	August	September	December	January
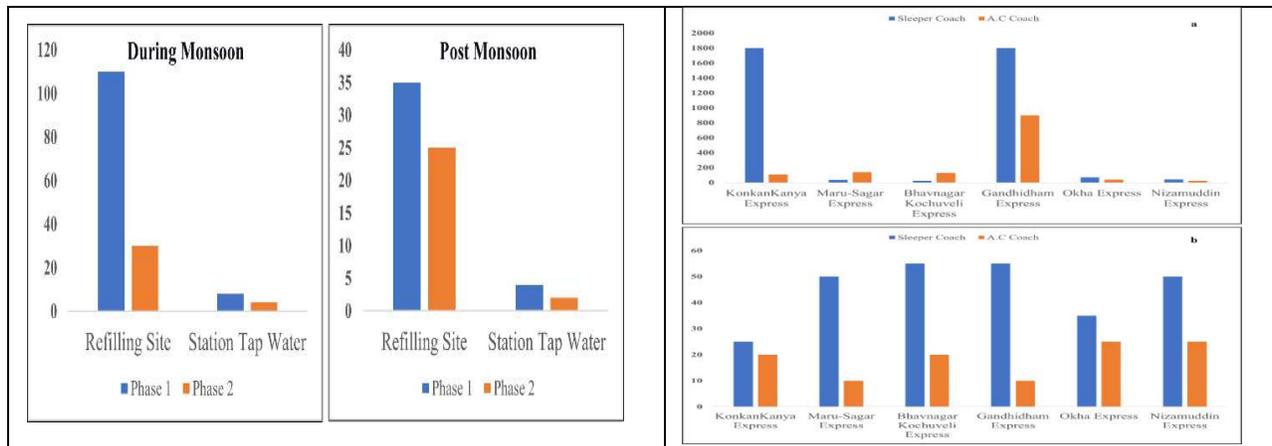
Fig. 1. Most Probable Number (MPN) of water samples collected from refilling sites and station tap water from Margao railway station during monsoon and post monsoon seasons.

Fig. 2. Most Probable Number (MPN) of water samples collected from sleeper and A.C coaches of different trains during monsoon (a) and post-monsoon seasons (b).

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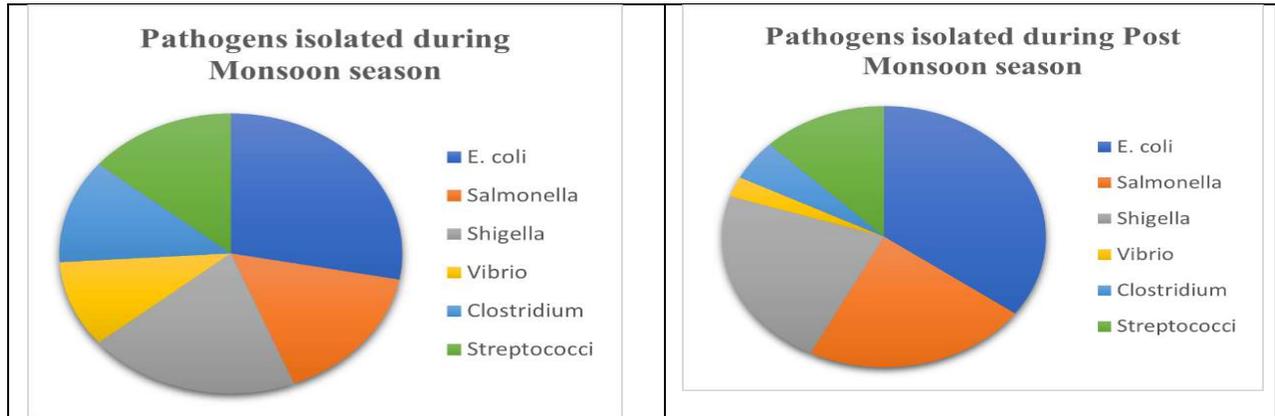
Fig. 3. Pie chart depicting various pathogens isolated from water samples collected during monsoon and post monsoon seasons.

RESEARCH ARTICLE

A Correlative Study of Maternal Hemoglobin with Neonatal Birth Weight, Maturity by Age and APGAR score

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ABSTRACT

Background and Objective: Maternal anemia, despite various research been done, still remains a major public health problem. It not only poses threat to the mother's health but also contributes to the rise in child morbidity and mortality. This study compares maternal hemoglobin with perinatal outcomes like neonatal birth weight, maturity by age and APGAR score and highlights the much preventable ill-outcomes of maternal anemia. In this observational-prospective study, 68 participants, each having singleton pregnancy, no comorbidities and no surgical or medical complications, were selected. Maternal hemoglobin values were recorded at time of admission and data of neonatal birth weight, maturity by age and APGAR score were noted at the time of delivery. Then using various statistical tests the relationship between maternal hemoglobin and perinatal outcomes were explored. 63.24% participants were found to be anemic. Higher incidence of low birth weighted and preterm babies was seen in anemic mothers and no increased incidence of low APGAR score was noted in anemic group. However, this study could not establish a significant statistical correlation between maternal hemoglobin and neonatal birth weight, maturity by age and APGAR score. The risk of giving birth to low weighed and preterm neonates is higher in anemic mothers as compared to mothers having normal hemoglobin values however it has not shown any statistically significant correlation in this study. This study was carried out in a tertiary healthcare center where every mother receives proper antenatal care and thereby significantly reducing the risk of perinatal outcomes associated with low hemoglobin values.

Keywords: APGAR Score, Hemoglobin, Low birth weight, Maternal anemia, Perinatal outcomes, Prematurity, Public health.

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INTRODUCTION

Anemia, a global health concern, has without any bias affected all age groups and genders of all the different ethnicities of the earth. Out of all the categories affected, anemia seen in pregnant women is a leading concern. During pregnancy the plasma volume increases rapidly while the red blood cell count lags behind. This discrepancy causes hemodilution and leads to reduction in blood hemoglobin [Hb][1-3]. For the red blood cells to increase in the blood, the demand of iron increases which ideally is to be met by iron stores of the body and diet. However, in developing countries like India, because of lack of proper balanced diet, the already depleted iron stores are not sufficient to meet the iron requirement, thereby further retarding the rate of increase of red cell mass ultimately leading to anemia [4]. Anemia not only puts the health of the mother in danger by reducing the immune response, imposing the danger of heart failure and aggravating the risks during childbirth, but also poses risk of poor fetal outcome like preterm delivery, low birth weight, low APGAR score thereby increasing risk of child morbidity and mortality [5-12]. According to data provided by WHO, the anemia is prevalent in 50.13% pregnant women in India [13]. Around the world 15 million babies are born preterm, out of which India is leading in the list of top 10 countries with greatest number of preterm births. In India, neonatal death due to prematurity is 43.85%[14].The leading cause of death among children below 5 years of age is due to complications arising from preterm birth [15][16].

Almost 15% of babies born worldwide have low birth weight [17]. Out of which many cannot survive past first month and those who do survive may suffer from stunted growth, low IQ and adult onset chronic diseases such as diabetes and obesity [18-20]. Most of the above stated ill-fated outcomes can be prevented by simply correcting the anemia prevalent in pregnant women. Many studies have been done regarding effect of maternal hemoglobin on perinatal outcomes [21][22]. Some have shown poor perinatal outcomes associated with low hemoglobin levels. Some have shown a U-shaped relationship between maternal hemoglobin and poor outcomes which means that complications like IUGR, premature delivery and maternal hypertension are seen with both high hemoglobin values [>13.2g/dl] and low hemoglobin values [21][23]. Some have not been able to prove any association of maternal hemoglobin with perinatal outcomes[21][24]. Thus not enough data is available to strongly associate the effect of maternal hemoglobin on perinatal outcomes. This study compares the maternal hemoglobin, recorded at the time of admission, with parameters of baby like birth weight, age of maturity and APGAR score. Results and conclusion have been derived from the same to shed some light on how it affects peoples' state of living.

AIMS AND OBJECTIVES
To find out the effect of maternal hemoglobin on neonatal birth weight, maturity by age and APGAR score.

MATERIALS AND METHODOLOGY

Type of study This is an observational and prospective study.
Study Population Antenatal patients who delivered within 15th January 2021 to 15th March 2021 in Parul Sevashram Hospital.
Sample Size This study includes the data of 68 participants who delivered at Parul Sevashram Hospital.

Selection Criteria
- All mothers with single intra-uterine fetus have been considered in this study.
- Mothers with medical or surgical complications or any co-morbidities have been excluded from the study.

Data Collection
- The hemoglobin value of the mother at the time of admission was recorded.
- The data of the neonate such as birth weight, age and APGAR score calculated by pediatrician was collected.

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The mothers were classified into different categories according to their hemoglobin values [taken at the time of admission]. The effect of maternal hemoglobin status on neonatal outcomes like birth weight, maturity by age and APGAR score were studied by calculating p-value, Chi-square test value, statistical test t value, Two tailed probability P, Pearson's correlation coefficient r and 95% confidence interval for r using Statistic Product and Service Solution [SPSS] software and respective conclusions have been drawn from the results obtained.

RESULTS

In this prospective study, 68 mothers with their respective newborns were selected according to the criteria of having singleton pregnancy with no medical or surgical complications or co-morbidities. Out of 68 mothers, 43 mothers i.e. 63.24% participants were anemic according to WHO criteria. 37 mothers came under the category of mild anemia whereas 6 mothers were moderately anemic. None of the participants were under the category of severe anemia. The mean hemoglobin concentration of this study is 10.64 ± 1.392 gm/dl which falls under the category of anemia. In Table 1 the mothers are categorized according to their hemoglobin status likewise the newborns according to their birth weight. Out of 17 low birth weighed newborns, 9 were born to mothers who were anemic. The chi-square test value turned out to be 1.101, statistic test t -0.570 and two-tailed probability P= 0.5705. The Pearson's correlation co-efficient r is 0.0312 while 95% confidence interval for r is from -0.2088 to 0.2676. No significant correlation was found between hemoglobin levels during pregnancy and neonatal birth weight [p=0.5767].

Table 2 shows that out of 17 premature births, 10 premature newborns were of mothers who were anemic. The chi-square value turned out to be 2.850 with statistic test t -0.635 and two tailed probability P=0.5276. The Pearson's correlation co-efficient r is 0.0327 while 95% CI of r is from -0.2073 to 0.2691 There was no statistically significant association between maternal hemoglobin values and preterm birth [p=0.2405]. Table 3 groups newborns according to their respective APGAR score. In this study 6 newborns had low APGAR score. The chi-square test value is 0.918, test statistic t -0.528 and two tailed probability P is 0.5990. The Pearson's correlation co-efficient r is 0.115 while 95%CI is from [-0.3592] to 0.1098. No statistically significant correlation was found between maternal hemoglobin values and neonatal APGAR score [p=0.6320].

DISCUSSION

The study includes 68 participants out of which 43 participants were anemic. No statistically significant correlation was found between maternal hemoglobin status and neonatal outcomes-birth weight, maturity by age and APGAR score in this study as the p-value calculated for each variable turned out to be more than 0.05. Although 63.24% participants were anemic in this study, newborns of only 20.93% anemic mothers had low birth weight. This is in contradiction to the results obtained by several studies done in this field along with the literatures reviewed previously [21][25][26]. In an article published in Iranian Journal of Blood and Cancer, a significant correlation was found between the maternal hemoglobin in second and third trimester with low birth weight of newborns [21]. Also, the study by Lumbanraja SN, et al. showed a strong association between maternal hemoglobin and low birth weights [25]. Both these studies have one method in common i.e. they interviewed the participants in first trimester and followed them up to their respective time of deliveries. Both the studies took the hemoglobin values of all three trimesters to evaluate and analyze its effect on neonatal outcomes. Therefore, elucidating the impression that low birth weight is observed more frequently if anemia persists for a longer duration in pregnancy. In addition to this it was noted that despite the lack of a statistically significant correlation between maternal hemoglobin and birth weight of the newborn, the risk of giving birth to a low birth weighed newborn was more prevalent among the population of anemic mothers as compared to that seen among non-anemic mothers.

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Premature birth is more prevalent among anemic mothers as compared to non-anemic mothers. However, no statistically significant correlation was found between maternal hemoglobin levels and maturity by age in this study. Similar findings were reported in a study done by Lumbanraja SN, et al. where too no significant association was found between these two variables [25]. On the contrary, many studies including the one done by Lone FW, et al show a significant relation between them [26]. A study done by Scholl TO, et al shows that if hemoglobin levels are less than 10.5gm/dl, the risk of preterm delivery increases by five-times which is also supported by study done by Stephen G, et al. [25][29][30]. Equal prevalence of low APGAR score among the anemic and non-anemic participants was observed in this study thereby suggesting no relation between the hemoglobin status of the mother and APGAR score. However, this is inverse to the findings reported by Alizadeh L. et al and also to the study done by Lone FW [21][26]. The results derived in this study differ from expected findings. This may be due to many reasons.

The sample size of this 2 months long study is 68 participants which is around 1/12th of the total deliveries done in Parul Sevashram Hospital. Thus, it confines the study to give only a small discontinuous representation of the actual bigger picture. In addition to this a newly diagnosed anemic mother is given complete antenatal care at our hospital which is a tertiary care center. This antenatal care and intervention markedly decrease the risk of many unfavorable neonatal outcomes and thus despite having hemoglobin values which are less than what is prescribed normal for a pregnant woman by WHO, the hemoglobin values might not be low enough to negatively affect the pregnancy outcomes. India's healthcare system has a huge burden of maternal anemia most of which is attributed to iron deficiency in diet. However, a part of population suffers from anemia due to micronutrient deficiencies which largely remains unaddressed till date. Such anemia will remain unresponsive to the normal iron + folate supplementation given as a part of regular antenatal care. Also, many confounding factors may independently influence perinatal outcomes some of which as reported by Shah S, et al are socio-demographic factors, maternal illiteracy and paternal illiteracy. These factors have been reported to increase the tendency of premature births [28].This study has not taken into consideration the literacy status of the women delivering here and thereby cannot show that whether literacy status was the reason why preterm births were relatively low as compared to that seen in tribal area. Thus, this study might not have significantly linked poor perinatal outcomes with low maternal hemoglobin values but it does raise a few questions: Does shorter duration of anemia imposes the same risk as long-standing untreated anemia during pregnancy? Which are the other unknown confounding factors which effect the perinatal outcome and how strong is their influence?

CONCLUSION

From this study we can conclude that risk of giving birth to low birth weighed and preterm newborns is more prevalent in anemic mothers as compared to non-anemic mothers. However, no statistically significant correlation was found between maternal hemoglobin status with birth weight and maturity by age of the newborn (p>0.05). Moreover, no relation of maternal hemoglobin and APGAR score was observed in this study. These results are in contrary to many previous research done in this field. This is due to the confounding factors like socio-demographic factors, micronutrient deficiency anemia, maternal and paternal illiteracy, etc. Also Parul Sevashram Hospital is a tertiary care center and so proper antenatal care is provided to every mother thereby significantly reducing the risk of poor perinatal outcomes. This merits a larger sample size especially from lower healthcare centers as these centers are usually approached by people living in peripheries who have not had proper medical care during pregnancy.

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Table 1 correlating maternal hemoglobin with birth weight of the newborn.

	Low birth weight [<2.5kg]	Normal birth weight [>2.5kg]	Total
Mildly anemic mothers [Hb= 9 to <11gm/dl]	8	29	37
Moderately anemic mothers [Hb<9gm/dl]	1	5	6
Non-anemic mothers [Hb≥11gm/dl]	8	17	25
Total	17	51	68

Table 2 correlating maternal hemoglobin with maturity of the newborn

	Premature birth [<37 weeks]	Mature by age [≥37 weeks]	Total
Mildly Anemic mothers [Hb= 9 to <11gm/dl]	7	30	37
Moderately Anemic mothers [Hb=<9gm/dl]	3	3	6
Non-anemic mothers[≥11gm/dl]	7	18	25
Total	17	51	68

Table 3 correlating maternal hemoglobin with APGAR score.

	Low APGAR Score at 1 min [<8]	Normal APGAR Score at 1 min [>8]	Total
Mildly Anemic mothers [9-11gm/dl]	3	34	37
Moderately Anemic mothers [<9gm/dl]	0	6	6
Non-anemic mothers [>11gm/dl]	3	22	25
Total	6	62	68

RESEARCH ARTICLE

Enhancing Signal Processing Efficiency: FPGA-Implemented Moving Average Filter

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ABSTRACT

This Paper investigates the use of a Moving Average Filter (MAF) in signal processing on Field-Programmable Gate Arrays (FPGAs), emphasizing its importance in noise cancellation applications. Moving average filters are essential for improving data quality by smoothing signals and lowering noise in different domains. The paper explains the basic idea behind digital filters and moving average filters and their importance for noise cancellation. It highlights how they can remove high-frequency noise components from digital data. Designing and perfecting a unique moving average filter for FPGA-based HDL implementation is the primary objective of this study.

Keywords: Moving Average Filter, Digital Filters, FPGAs, Noise Cancellation, HDL.

INTRODUCTION

Digital signal processing (DSP) has found significant utility in many fields in the modern digital age. Filtering, an ancient technique for separating desired signals from unwanted noise, has undergone a remarkable transformation with the adoption of digital methods. Digital filtering offers distinct advantages over its Analog counterpart, highlighted by greater precision, reduced filter complexity, and the availability of various digital filter types and configurations. Different numbers are suitable for specific applications. An inherent limitation of analog filters is their dependence on components such as resistors and capacitors. Changes in the values of these components over time or due to environmental factors, a phenomenon known as component drift, can cause changes in the filter's

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cutoff frequency. This gap has drawn attention to digital filters, whose characteristics are determined by programmable coefficients, thus maintaining stability and consistency over time. Digital filters provide superior performance regarding faster attenuation, narrower transition width, and reduced overshoot in time domain operation compared to analog counterparts. Analog filters exhibit ripples in both the passband and stopband, while digital filters exhibit a flatter response. Hardware implementations of filtering, traditionally implemented using programmable digital signal processors (PDSPs) or application-specific integrated circuits (ASICs), have seen a notable change in the programmable gate array (FPGA) technology field. This transition is mainly due to the lower cost and greater flexibility offered by FPGAs, making them the preferred choice for implementing filters in various applications. In short, the digital era has ushered in a revolution in signal processing through digital filters, overcoming the limitations of analog filters. Digital filtering delivers greater precision, reduced filter complexity, and consistent performance over time, making it the preferred choice in many applications. Field Programmable Gate Array (FPGA) technology has become a flexible and cost-effective platform for implementing digital filters, thereby driving their adoption in modern fields [1]

Digital Filters

Digital filter mainly has two types: (A) FIR Filter (Finite Length Impulse Response): FIR filters have a finite-length impulse response, making their behavior predictable and stable. The finite impulse response (FIR) filter is a non-recursive filter in that the output from the filter is computed by using the current and previous inputs. It does not use earlier output values, so there is no feedback in the filter structure [9]. (B) Infinite Impulse Response Filters (Infinite Length): The endless impulse response (IIR) filter is a recursive filter since it uses the current and past inputs and outputs to calculate its output. There is output feedback in the filter structure since the filter uses the output's prior values [9]

FIR Filter

Finite impulse response (FIR) filters are essential tools in digital signal processing, designed to precisely modify, enhance, or extract information from digital signals. Their finite impulse response, linear phase characteristics, and adaptability make them indispensable in applications ranging from audio equalization to image processing. The FIR called filter is a non-recursive filter because the output signal depends only on the input signal. The figure 1 shows a direct implementation of an FIR filter [4].

In the above figure, M is the order of the filter, x(n) is the input signal, y(n) is the output signal, and h(0) to h(k) is an impulse response signal, also known as a filter. Filter coefficient. By integrating the impulse response and the input signal, we can obtain the output of the filter [3]. The equation of the filter is given by

$$y(n) = \sum_{k=0}^{M-1} h(k)x(n-k) \ldots \ldots \ldots \ldots (1)$$

Implementation Of Moving Average FIR Filter On FPGA

By Direct form realization and Transpose Direct form realization, we can implement the FIR filter in Hardware Descriptive Language (HDL). The traditional Multiply and Accumulating Units (MAC) implementation of the FIR filter is easy and more useful [8]. To implement FIR, filter The main components of the implemented circuit are as follows.

Memory

Prepared to store past packet location data. Z^{-1} in Figure 2. means a one-turn delay.

Adder

Adder is designed to reduce the number of stages and is the key to the stable operation of the FPGA used in the board. This phase reduction is effective in avoiding errors due to clock skew in the FPGA and in reducing power consumption and circuit area (or number of gates) on the FPGA.

Multiplier

Built-in multipliers are used to meet the high-speed operating requirements. Therefore, this built-in multiplier is one of the constraints on the number of taps of the FIR filter.

Shift-Register

This is used to add delay to adjust the delay to one or two-round intervals.

Advances in field programmable gate arrays (FPGAs) have opened up many applications for these general-purpose devices. FPGAs are especially useful in the context of data path design, where their mesh structure can be effectively leveraged [5]. The inherent programmability of FPGAs provides a level of adaptability not typically available with custom solutions while maintaining commendable system clock speeds. However, FPGAs have some disadvantages. They mainly revolve around the finite number of logic operations that can be performed on a particular FPGA device and constraints on signal routing options for connecting logic operators in the array [6]. Verilog, a widely adopted hardware description language, is a favorite of hardware designers for many reasons. Its extensive support for integrated circuit design covers a multitude of functions and data types related to integrated circuits. Additionally, the availability of a large library ecosystem completes its appeal.

Verilog also excels at facilitating the modeling of hardware behavior, an essential aspect when implementing finite impulse response (FIR) filter generation programs [7] [8]. Here, we are going to implement the Moving average FIR filter. Moving average filters are fundamental tools in signal processing and time series analysis, analyze to improve data clarity by reducing noise and highlighting underlying trends [11]. This filter works by averaging a set of data points within a defined window, cycling the data sequentially. This moving window allows the filter to handle fluctuations and detect underlying patterns, making it a valuable tool for applications ranging from financial analysis to sensor data processing [11].

Here, the FIR filter and 3rd order Moving Average filter have been designed. The input-output relationship is given by:

$$y(n) = \frac{1}{M} \sum_{i=0}^{N-1} x(n-i) \dots\dots\dots\dots\dots\dots (2)$$

First, implement the 3rd order Moving Average FIR Filter in MATLAB R2021a by generating noisy simulated inputs and checking the output after passing through its coefficient generated in MATLAB R2021a. In Figure 3 show noisy signal and in Figure 4 show filter output waveform

Filter performance of simple moving average In MATLAB with different type of noise is analyses and calculate SNR for all is given table 1.

RESULT

Low-latency real-time processing is a fundamental feature in FPGA-based FIR filters since it provides predictably speedy data filtering to fulfill application requirements. To guarantee optimal resource utilization, these filters should function within the available FPGA resources, which include logic cells, memory blocks, and DSP slices. Power consumption is also important, and FPGA implementations should adhere to the application's power budget. Furthermore, the FPGA-based FIR filter should deliver real-time processing capabilities without considerable delays, ensuring that it can successfully meet the real-time signal processing needs of various applications.

CONCLUSION

The FPGA-based simple moving average filter is an innovative solution that is highly effective at real-time signal smoothing and serves a variety of uses, including communication systems, audio processing, and sensor data filtering[5]. Its utilization of FPGA technology guarantees low latency and high throughput, enabling it to quickly and precisely meet the demanding requirements of real-time signal processing[6]. This design is unique in that it allows users to tailor the filter to meet certain signal characteristics and application needs, maximizing its performance in a variety of settings. Because it uses FPGA resources efficiently and uses less hardware, it is a cost-effective solution[3]. Its power economy also makes it perfect for battery-powered and portable applications. It can process data at high frequencies with high accuracy and precision because of its parallel processing and pipelining capabilities[2].

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Table 1 : SNR calculation of different type of noise

Type of Noise	Input signal SNR	Output signal SNR
Random noise	11.98 dB	17.55 dB
Gaussian noise	12.05 dB	17.54 dB
Uniform noise	13.43 dB	18.03 dB
White noise	15.51 dB	18.88 dB
Low frequency noise	13.00 dB	17.87 dB
Periodic noise	11.42 dB	17.34 dB

Table 2 : Area use by simple moving average filter on FPGA

Logic Utilization	Used	Available	Utilization
Slice LUTs	29	20800	<1%
Slice Resisters	44	41600	<1%
LUT as Logic	29	20800	<1%

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LUT as Flop pairs	35	20800	<1%
Bonded IOB	28	106	<27%
BUFGCTRL	1	32	<4%
DSP Block	0	90	0%
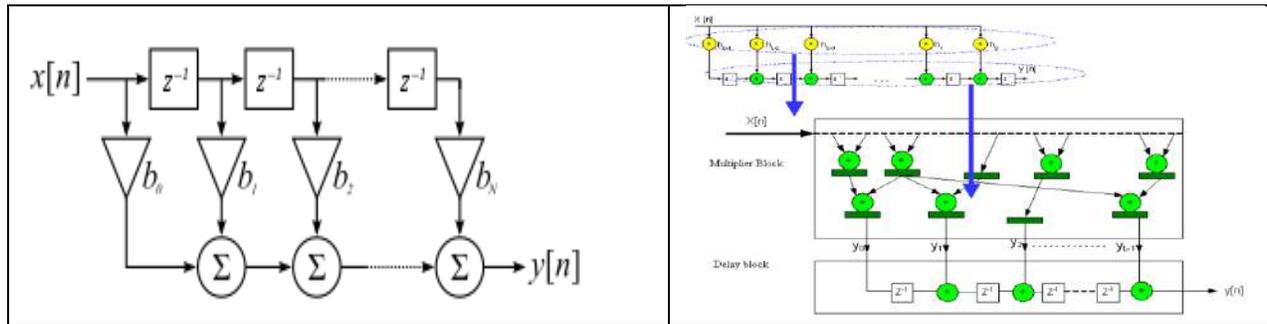
Figure 2 Direct form realization of FIR filter
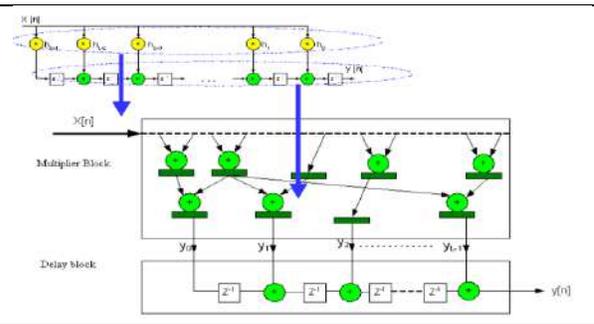
Figure 3 : Implementation of FIR Filter
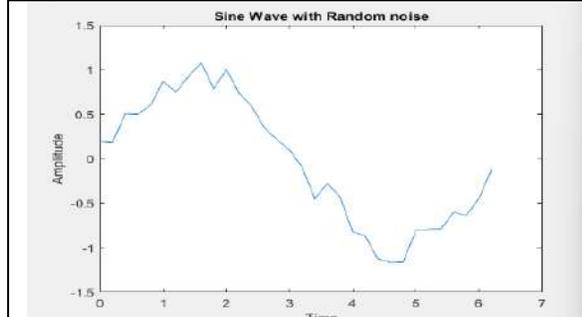
Figure 4 : Input signal with random noise
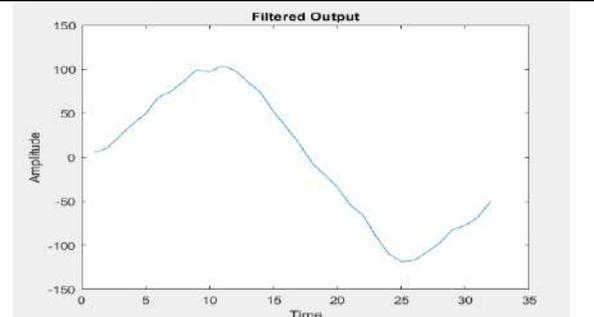
Figure 5 : Moving average filter output
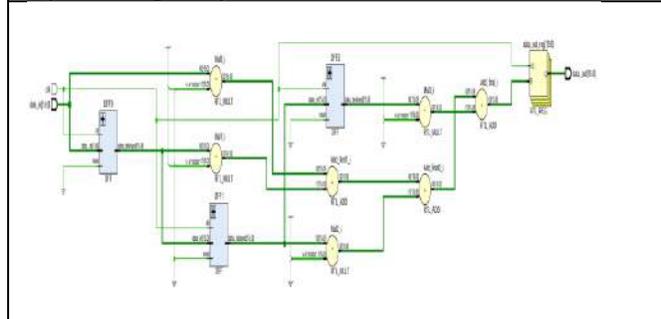
Figure 6 : Schematic of Moving Average filter

Figure 7 Behavioral simulations of Moving Average filter
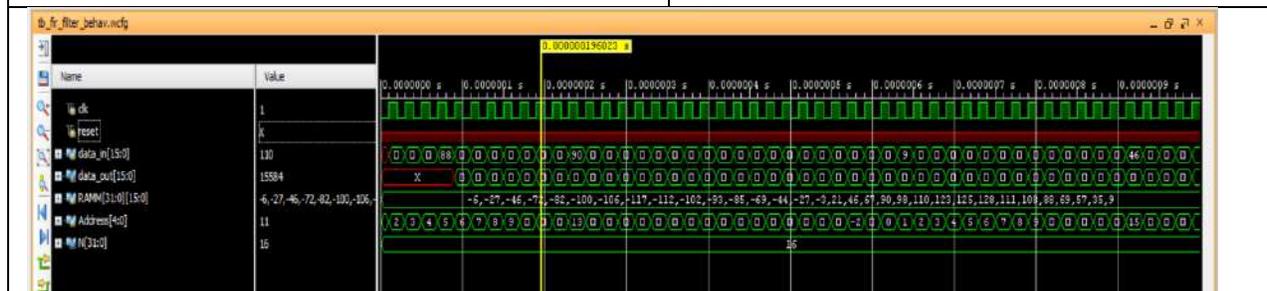
Figure 8 : Timing analysis of the Moving Average filter

REVIEW ARTICLE

Dental Caries Detection using Convolutional Neural Network: a Review

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ABSTRACT

Dental caries is a common chronic disease worldwide, also called as tooth decay. It is caused by bacteria and poor dental hygiene, leading to tooth loss. Sometimes, cavities can be stopped without detection, but if left untreated, the infection can spread to the teeth's inner tissues or infected with one another. Without early and appropriate care, the infection can spread to soft tissues in the cheek, jawbone, or other areas of the head and neck. Although not life-threatening, dental caries increase the risk of infection, breathing restriction, and odontogenic infections. Early detection and treatment are crucial to prevent complications and reduce the need for invasive procedures. Therefore, accurate and timely identification of dental caries development is essential for effective prevention and treatment. This Paper attempts to diagnose dental cavities early on using CNN so that treatment may be conducted conveniently and successfully.

Keywords: Dental caries, Artificial neural network (ANN), Soft Computing techniques, Convolution Neural Network (CNN).

INTRODUCTION

Cavities, or tooth decay, are permanent holes in the teeth's hard surface caused by oral bacteria, frequent eating, sugary beverages, and inadequate cleaning. They are a prevalent health issue worldwide, especially in children, teenagers, and elderly individuals. If left untreated, cavities can grow and cause tooth loss, infection, and severe dental pain. It is an infectious chronic disease that impacts many people. It is spread by cariogenic bacteria that stick to teeth and break down sugars to form acid, and over time removes minerals from tooth structure. According to the most current estimates, nearly 40 per cent of the population will develop dental cavities in their permanent teeth. A dental cavity is an increasing and developing condition that, if left untreated, can seriously harm other teeth and

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even lead to tooth loss. Caries can be caused by factors such as improper tooth cleaning, excessive snacking, oral bacteria, and drinking sugary beverages. However, The primary cause is the bacteria that is present in the mouth, which creates acids that can dissolve tough tissues like dentin, enamel, and cementum. Cavities can form on any surface of the tooth. Here are some of the most common types of cavities and where they can be found:

- **The smooth surface:** This cavity destroys tooth enamel over time. With appropriate oral hygiene, you can avoid and occasionally reverse it. This type of dental decay between the teeth is common in people in their twenties.
- **Pit and rift decay:** Cavities form on your tooth's chewing surface. Decay can also affect the front of your rear teeth. Pit and fissure deterioration usually begins in adolescence and advances swiftly.
- **Root decay:** It is more common in adults who have receding gums. Gum recession exposes the roots of your teeth to bacteriaand acid. It is difficult to prevent and cure root decay.

Stages of Dental Caries
Stage 1: Initial demineralization
The outer coating of your teeth is made up of a type of tissue known as enamel. Enamel is the toughest tissue in your body and is largely composed of minerals.
However, once a tooth is exposed to plaque bacteria's acids, the enamel begins to lose these minerals.

Stage 2: Enamel deterioration
Continued enamel deterioration leads to enamel erosion, resulting in tooth decay, which can cause white spots to darken and dental caries to form.

Stage 3: Dentin decay
Dentin is the layer of your teeth directly beneath the enamel. It's considerably softer than your enamel. As a result, once plaque and germs reach this layer, cavities grow more quickly. You may notice tooth sensitivity at this point. Your tooth stains may also turn a darker brown.

Stage 4: Damage to the pulp
The pulp is the innermost layer of your tooth. It is made up of nerves and blood vessels that carry nutrients and keep your tooth alive. You may experience pain if cavities reach your pulp. Redness and swelling in the gums around your tooth may also appear. The patches on your teeth may darken to a dark brown or black.

Stage 5: A deep hollow
If left untreated, can lead to infection. This causes a pus pocket to grow at the tip of your tooth root (periapical abscess). Pain that extends into your jaw or face is one of the symptoms. You may also experience face edema as well as enlarged lymph nodes in your neck. A dental abscess can now spread to neighbouring tissues and other parts of your body. In rare situations, the infection may spread to your brain or circulation (sepsis).
Cavity signs and symptoms differ based on the degree and location of the cavity. As the degeneration proceeds, it may cause the following signs and symptoms:
- Toothache, inexplicable pain, or pain that develops for no obvious cause
- Sensitivity of the teeth
- Pain ranges from mild to severe while consuming something sweet, spicy, or cold.
- visible pits or holes in your teeth
- Stains on any surface of a tooth that is brown, black, or white
- When you bite down, you feel pain.
Back teeth, particularly molars and premolars, are more prone to decay due to their complex grooves, pits, and roots, making them more difficult to clean than front teeth.

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Risk Factors of Dental Caries

Sugary drinks like milk, ice cream, and honey can cause tooth decay due to their prolonged stickiness. Regular consumption of these drinks fuels oral bacteria, leading to the formation of acids that wear down teeth. Consuming acidic liquids all day can further exacerbate this issue. Newborns who consume these beverages in their nighttime bottles can also experience tooth decay due to the bacteria that nourish decay-causing bacteria. If plaque is not removed soon after eating and drinking, it can contribute to tooth decay. Fluoride, a naturally occurring mineral, aids in the prevention and treatment of cavities. It's in public water systems, toothpaste, and mouthwash. Dry mouth, induced by a lack of saliva, aids in the removal of food and plaque from the teeth. Salivary chemicals neutralize the acid produced by bacteria. By lowering saliva production, several drugs, medical illnesses, radiation, and chemotherapy might increase the risk of cavities. Wearing out fillings or dental equipment. Over time, dental fillings might degrade, break down, or acquire sharp edges. This promotes plaque development while making removal more challenging. Dental implants can loosen, leading to tooth decay. GAD, or gastroesophageal reflux disease, causes stomach acid reflux, eroding enamel, and exposing dentin to bacterial attack. Dentists may recommend a doctor to determine if gastric reflux is causing enamel loss. Anorexia and bulimia can cause tooth degradation and cavities due to frequent vomiting, as stomach acid washes over teeth. Hence Dental Caries Early detection is really important. Researchers' primary goals are to identify and determine the cause of these caries. In dentistry, soft computing tools are commonly used to make diagnoses and reduce diagnosis time. Although dental caries is the most prevalent condition worldwide, it is an important health concern. The average rate of dental caries in adults is approximately 100%. Despite being comparatively preventable, the disease mostly affects those in inadequate socioeconomic categories, and within the last thirty years, its prevalence has not decreased appreciably. A common chronic infectious disease referred to as dental caries occurs by microorganisms called cariogenic agents. They bind to teeth and consume sugars to generate acid, which gradually destroys the structure of teeth. Medical misdiagnosis has become widespread in recent years, and many people are affected directly or indirectly. Misdiagnosis caused by incorrect medical problem analysis and unsuitable pharmacological therapy worsens the disorders. As a result, soft computing approaches such as machine learning algorithms, neural networks, and convolution neural networks appear promising in the field of dentistry. Deep learning algorithms were developed as self-learning backpropagation algorithms, which aid in refining the output from the input data set while also increasing computing performance. Because of this CNN approach, it is widely employed in actual-life situations and in the medical industry. In simple terms, a convolution neural network is a neural network that has one or more convolutional layers. These networks are made up of neurons that can learn and have biases. Neurons accept some input function, process it using dot product, and ultimately (optionally) with a non-linear mapping function.

LITERATURE REVIEW

Dental Caries are a kind of chronic disease that occurs due to cariogenic bacteria. This bacteria produces acid by metabolizing sugar. It adheres to the tooth. Over some time, it demineralizes the tooth. This article gives an overview of dental caries and its detection using a convolution neural network. Exploring the identification of dental caries using convolutional neural networks (CNNs) is critical in our daily lives. Early detection is critical for prompt intervention and reducing the need for invasive therapies, and CNNs may improve the accuracy of detecting caries in their early stages. This not only improves dental health results but also streamlines dental practice procedures, allowing dentists to make informed decisions and optimize treatment options. As technology progresses, study in this field can help to build revolutionary dental imaging tools and AI-powered systems that improve caries detection and diagnosis. Furthermore, the work is to use digital color images to identify dental cavities early on, allowing for simple and efficient treatment. This categorization is also appropriate for telemedicine, such as telehealth informatics.

(Adnan Qayyum. *et. al,* 2023) This study proposed that early detection of dental caries can prevent invasive treatment and enable preventive treatment. Dental radiography is a widely used tool for detecting and diagnosing caries. Deep learning techniques for caries detection require large-scale annotated data, which is scarce in clinical

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settings. An efficient self-training-based method for caries detection and segmentation uses a small set of labelled images and a large collection of unlabelled images. The proposed self-supervised learning strategy improves performance by 6% and 3%.(Yılmaz, Hülya, and Sultan Keleş 2018)This review's objective is to provide broad information on current techniques for detecting dental cavities and to highlight the advantages of using them in addition to more established techniques. the author has concluded that None of the individual's listed methods on its own are enough for diagnosing dental caries. Future developments in diagnostic equipment may bring about slight modifications to the tooth's structure. A dental caries diagnosis will be made, and preventive measures will be taken to safeguard the tooth structures. (Vincent Majanga and Serestina Viriri 2022) This survey covers methods and strategies for segmenting and detecting dental pictures, including databases, performance evaluation protocols, segmentation techniques, and algorithms based in academia and industry. Dental radiography may be useful in identifying dental images, however the methods in place now concentrate mostly on segmentation. Automatic blob detection approaches have the potential to enhance dental detection systems and enable human-based dental caries diagnosis.(Shashikant Patil and Vaishali Kulkarni b 2019). The author created an architectural assessment of the new caries sites model to have an accurate recognition of dental cavities. Adaptive dragonfly computation and NN classifier were used to complete the component extraction and placement.

METHODOLOGY

The use of Convolutional Neural Networks (CNNs) has been growing in many fields of research, such as dental caries detection and medical imaging. Here are several popular CNN techniques along with some current findings in this field of study that have been shown to have accurate results:
The above methods give different results which elaborate the importance of cnn in this research area. the results of this method are as follows: Depending on the dataset and particular application, U-Net-based techniques have shown encouraging results in dental imaging when it comes to segmenting dental caries and obtaining accuracies of 85% to 95% or higher. When used for dental caries detection tasks, ResNet variants have shown accuracy levels above 90% in certain experiments. ResNet architectures' efficacy in this field has been aided by their ability to handle intricate dental picture elements. Using the features from the pre-trained models and the process of fine-tuning dental pictures, transfer learning approaches have made it easier to construct strong dental caries detection models, with reported accuracies in the range of 85% to 95%.

Opportunities
Finding dental caries can lead to a number of benefits that have a big impact on people's oral health and larger healthcare systems. Early detection makes it easier to act quickly, enabling dentists to apply fluoride treatments or dental sealants, for example, which can stop or reverse the progression of caries and reduce the need for more invasive procedures like fillings or root canals.This not only retains more natural tooth structure, but also adds to improved long-term oral health and patient care experiences. The focus on dental caries detection propels technological advancements in dental imaging, diagnostic tools, and AI-driven techniques, boosting collaboration among dental practitioners, researchers, and technologists. These developments not only foster innovation, but also address oral health inequities, promoting equitable access to high-quality dental care and education for people of all backgrounds.

Key Disclosure of the Review
According to the above report, researchers in the area of dentistry are using CNN models for various types of imaging data sets to detect dental illness. The performance of each model varies based on the data set and model. So, in the proposed effort, we will use the CNN architecture to identify dental cavities early. According to the force's assessment, the deep learning approach is used for object localization the most. In the private sector, virtually little effort is made on dental issues. It is in our best interests to concentrate on clearly defined dental diseases using various techniques such as caries extraction and particular. A portion of CNN models are excellent for precise carry detection.

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CONCLUSION

Dental plaque is a risk factor for dental diseases like caries, gingivitis, and periodontitis. Detecting dental plaque early is crucial for maintaining oral health. This research aims to promote early diagnosis of tooth decay using multiple Convolutional Neural network models. Caries detection technologies aim to identify caries early and prevent it from progressing to cavitation. The article presents a deep convolutional neural network-based technique for automatically identifying dental caries.

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Table 1: CNN Methods

Sr no.	Method	Description
1	**U-Net Architecture**	ResNet is an architecture for deep neural networks that mitigates the vanishing gradient problem and allows for the training of deeper networks thanks to its residual connections.
2	**Residual Networks (ResNet):**	Using pre-trained CNN models—VGG, ResNet, or DenseNet—that were trained on massive datasets like ImageNet, transfer learning entails honing them on smaller, domain-specific datasets for applications like dental caries detection.
3	**Transfer Learning with CNNs**	CNNs' attention mechanisms improve the model's capacity to capture complex patterns and features by allowing it to focus on pertinent areas of the input image.

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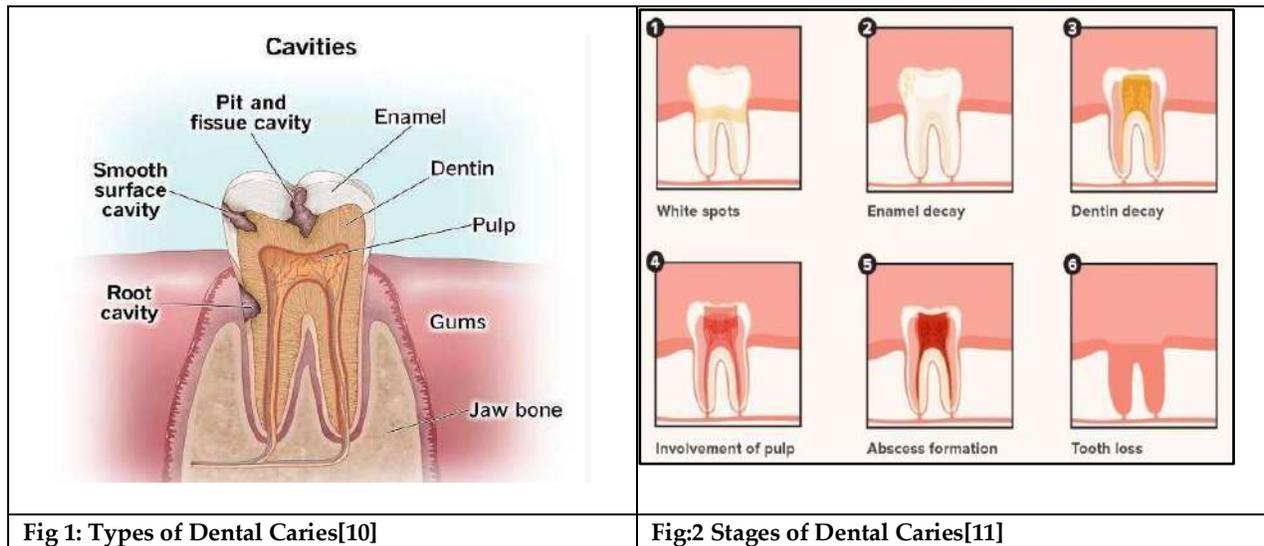
Fig 1: Types of Dental Caries[10]	**Fig:2 Stages of Dental Caries[11]**

RESEARCH ARTICLE

Survey of Indoor Environment Quality for Office Building

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ABSTRACT

The intricate phenomena of indoor air pollution arise from the ever-changing interplay of several indoor and outside environmental elements. This research was conducted in office buildings during pre-monsoon season. Relative humidity and temperature, particulate matter (PM2.5, PM10, PM1), carbon dioxide, formaldehyde and total volatile organic compound (TVOC) were measured throughout each building five days a week, at 30-minute intervals between 9:00 AM and 5:00 PM. Regarding thermal characteristics, the temperature in each building is marginally higher and relative humidity within the limits than the Indian Society of Heating Refrigerating and Air Conditioning Engineers (ISHRAE) standards. Notably, the average concentration of particulate matter, CO_2, HCHO and TVOC were recorded and compared with the standards establish by World Health Organization (WHO) and American Society of Heating Refrigerating and Air conditioning Engineers (ASHRAE) with building characteristics.

Keywords: Indoor air quality, Thermal characteristic, Environmental element, Office buildings, Standards

INTRODUCTION

The indoor air quality best (IAQ) depends at the awareness of pollutants released to air in relation to the dilution factor determined by means of alternative with fresh air. The indoor pollutants are able to affecting human fitness in a mess of methods (from pain felt a sensory stage to the extreme illnesses of the country of health), relying on the contaminant[1]. There are literally hundreds of air contaminants, each having various effects on the human body. From a World Health Organization estimation, it seems that a big percent of homes, in developed countries, have a high stages of toxic indoor air contaminants. Indeed, one of the reasons of the prevalence of certain illness (allergic

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reactions, poisoning, migraines, most cancers, and so forth.) seems to lie inside the degree of pollutants present within the environments in which normally spends most of the day [2]. Office homes that rating excessive in power and environmental overall performance have now grow to be flagships of sustainability inside the built surroundings as worldwide efforts are made to reduce carbon emissions. In the United Kingdom about 70% of power utilized in workplaces is channeled in the direction of making sure comfort for occupants. The fine of the indoor air surroundings relies upon at the layout and process of constructing structures that manipulate thermal consolation, IAQ, acoustics and illuminance. as per ISHRAE Providing and maintaining acceptable stages whilst preserving electricity costs and carbon emissions low is an electricity annoying workout that requires designers, owners and customers of homes to make the right stability among power saving imperatives and presenting comfort. Research has shown that IEQ is fundamental to the health and nicely being of the occupants specially in the UK in which many humans spend a huge share of their operating lives indoors. A poor first-class indoor environment might have a negative influence on any person's capacity to generate money as an employer because the expenses of absenteeism and occasional productivity most usually exceed the fee of power use related to maintaining applicable standards. On the other hand, true indoor environment excellent could enhance normal work overall performance by minimizing the outcomes of constructing related ailments and absenteeism [3].

Office buildings have significantly developed to grow to be controlled environments with advanced ventilating and air-conditioning systems. In latest years, workplace homes have no longer been considerably studied as compared to other similarly crucial indoor environments regarding the amount of time spent among the general population, which includes dwellings and faculties[4]. Moreover, similarly to the described fitness results because of indoor air contamination, the indoor environmental exceptional in offices may also have an impact on cognitive function and even subclinical disturbances might also and even mild abnormalities may cause productivity losses. Problems inside the indoor air of workplaces are problems which occupational health care frequently desires to do not forget when comparing the health risks of a work surroundings, but, in the intervening time, there may be very little information on the causal members of the family of indoor air difficulties and the mechanisms at the back of them. There is a growing studies interest on a part of occupational hygienists, air best in restrained areas, due to the fact the arrival of electronic gadgets in workplace environments has stepped forward the efficiency of the paintings at the expense of air first-rate. An increasing number of massive use of photocopiers and printers has been related to the constructing unwell syndrome (SBS) and their use is a major supply of threat to be taken into attention for an ok evaluation of chemical hazard inside the workplace[2]. Australian scientific studies, posted inside the magazine of American Chemical Society, says that running subsequent to a printer or copier in operation, it's miles equivalent to inhale cigarette smoke or to breathe exhaust fumes of traffic jam, for our lungs there may be little distinction.

In the final decades, the air excellent of indoor regions became of primary importance due to its effect on human fitness. The closure of natural openings of homes for power saving an experimental learning of the indoor air quality 193 functions, the procedure of untested new substances in addition to the negative air change affect extensively the indoor air pleasant[5]. An end result of this interference is the increase of many pollutants concentrations interior, consisting of CO, CO_2, PM10, PM2.5 and total VOCs. Researchers have centered at the measurement of pollutants' concentrations in houses, places of work, shopping shops and restaurants in which people occupy most in their normal time, with a purpose to examine the distinct indoor atmospheres and pick out pollutant's assets[6]. A first-rate part of particulates originates from the outdoor air and enters the indoor surroundings thru the ventilation structures, physical openings and cracks, whilst tobacco smoking, terrible cleansing behavior, resuspension and bad renovation of the air flow machine filters result in even higher levels. It must be referred to that emissions from elderly substances normally account for up to 30% of the full VOCs, at the similar time as those generated from activities, office equipment, building upkeep and cleansing merchandise account for practically all of VOCs [7]. Additionally, numerous educations have confirmed that the indoor air nice depends on the vicinity of the homes, the ventilation traits and the resources of air pollution, which exist at the area, while it became tested that indoor air pollution tiers can often exceed the out of doors degrees [3]. In this paper, the objective of the present work become to take a look at experimentally the indoor air excellent fame regarding PM1, PM2.5, PM10, CO_2, HCHO and TVOC

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in decided on differently office areas for evaluation functions. The experimental campaigns protected several days in each building to be able to include one-of-a-kind indoor conditions. All measurements were collected within the duration of the pre monsoon period.

MATERIAL AND METHODS

The four office buildings are situated on the first floor of the different commercial complex. which is in a suburban area close to moderate traffic roads. In offices around 15 to 20 peoples work on their regular office time 09:00 am to 05:00 pm [6]. All the buildings equipped with electronic computers, printers and furniture. Office 1 and 4 covers an area of 40 m² and office 2 and 3 covers 100 m² and 300 m². It must be noted that smoking is not permitted in any office. Measurements were taken in all the offices building at every 30 min interval [7]. The present work aims to contribute, through an initial learning phase, to the quantitative characterization of Particulate matter (PM2.5, PM10, and PM1), Carbon Dioxide (CO_2), Formaldehyde (HCHO) and Total volatile organic compound (TVOC) emitted from the office building without a filtering system also here are two comfort parameters Temperature and Relative Humidity also quantifying[5]. The sampling procedure continued for five days from Monday to Friday from around 9 a.m. to 5 p.m. in four various locations within each building. except in the case of PM2.5 (one site per building) According to the World Health Organization. The sample devices were strategically positioned on four separate levels and in four distinct orientations across the building: north, south, east, and west. Additionally, if the building had both types of working spaces, the variety of rooms had been considered, specifically the open spaces and cellular offices[8]. The sample period was chosen to strike a balance between the desire to define average concentrations in office buildings to be able to estimate long-term worker exposure and technological feasibility. Similarly, the quantity of sample points per building was determined by balancing detailed IAQ characterization for the whole structure with financial and feasibility concerns [9].

The samplers were positioned in the central of each room, at a height of around 110 cm, which is the breathing zone of sitting inhabitants, and not closer than 1 meter from the wall. Ventilation routes and heating sources, such as the sun, were excluded. Whenever possible, VOC-emitting adhesives and materials were scrupulously avoided while installing the samplers [4]. Utilizing a real-time monitoring system to measuring the indoor air quality parameters. Intelligent air quality detector was used to measure a level of pollutants with range Particulate matter PM2.5, PM10, and PM1 (0-999 µg/m3), CO_2 (0-5000ppm), HCHO (0.000-1.999 mg/m3) TVOC (0.000-9.999 mg/m3) Relative humidity (20% - 85%) and Temperature (20 °C - 50 °C) [10].

RESULTS AND DISCUSSION

The Thermal Environment
Throughout the sample time, the average inside temperature of building 1, building 2, building 3 and building 4 were 28°C, 27°C, 29°C and 30°C. Relative humidity were 47%, 58%, 65% and 49%. In all the buildings average temperature slightly above the ISHRAE standards and relative humidity within the prescribed limits [5]. It was a pre monsoon time so the outdoor temperature is also higher.

Indoor Air Quality
PM1, PM2.5 and PM10 Concentration Inside Office Buildings
The amounts of particulate matter present in indoor air of three different sizes in the occupied spaces were assessed. These were PM1, PM2.5 and PM10. The World Health Organization notes that complete protection for every individual against all possible adverse health effects of PM is unlikely to be guaranteed by any limit value due to the considerable inter-individual variability in exposure and in the response to a given exposure. As a result, the lowest concentrations feasible should be achieved in the context of local constraints, capabilities, and public health priorities[8]. During the research period, there were notable changes in the concentrations of PM1, PM2.5, and PM10

in every office building. During a 24-hour period, the concentrations of PM1, PM2.5, and PM10 in all office buildings were found to be below the WHO guideline value. Regular cleaning operations are conducted in all office buildings.

CO_2 Concentration Inside Office Buildings

One simple and reasonably priced method to address the degree of outside air missing from the recirculated air inside a building is to monitor the CO_2 concentration in the air under the building's interior. Human breathing causes CO_2 to be created inside the structure. About 100 times as much CO_2 is present in each expelled breath as intake breath [11]. If an inhabited indoor area has a CO_2 concentration, it may be used to determine if the building's air exchange balance is suitable, meaning that the right quantity of filtered outside air is being mixed with the air that has been flowing inside the structure. For any office building, the American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE) advises that the interior air CO_2 levels be below 1000 parts per million ppm.

HCHO Concentration Inside Office Buildings

In every building HCHO concentration were measured. Building 2 had a greater concentration of HCHO than the other buildings. These sources include ornamental woodwork found on ceilings and walls. High furniture density resulted in a greater HCHO concentration regardless of the building's age [12]. The primary source of HCHO emissions in the indoor workplace was furniture, namely the adhesives employed in the medium density fiberboards. Overall, these data suggested that interior decoration and furniture were more likely to be the main sources of HCHO emissions than other factors [13].

TVOC Concentration Inside Office Buildings

An assessment of the indoor concentration levels of the total volatile organic compounds (TVOCs) was also carried out. This investigation was unable to assess the different organic compounds separately. The assessment was based on the concentration degree of several organic compounds combined [14]. Among Four buildings, noticeably less TVOC concentration (0.3 mg/m^3) found in the building 1. building 3 and building 4, however, considerably greater (0.5 mg/m3) concentration was noted in the office building 2. The notably reduced density of wooden furniture in buildings 1, 3, and 4 in comparison to other buildings may be related to a lower concentration of volatile organic compounds (VOCs) in those particular buildings. Furthermore, the building only included a single laptop computer, one printer, and no copier, in contrast to building 2's abundance of desktop PCs, printers, and copy machines. The increase in TVOC concentration in the afternoon may have been caused by the employees of all office buildings using personal care products and scents. According to earlier research has also showed that using these items may cause the TVOC content in a poorly ventilated environment to progressively rise. The operation of floor doors to allow office personnel entrance may be the cause of the morning decrease in TVOC concentration across all levels. Due to a brief increase in airflow, this may have reduced the TVOC concentrations inside the floor. Building 2 had a substantially higher TVOC content (0.5 mg/m^3) than the other building. This might be explained by the fact that there were more freshly varnished hardwood furniture and wooden cubicle per unit area of a floor during the sample period.

CONCLUSION

The quality of the air inside four office buildings was assessed during two experimental campaigns performed and the data obtained were very interesting. Most working persons spend their days in various office buildings. From the standpoint of optimal productivity and the wellbeing of the employees working there, it is critical to maintain the IAQ in office buildings. According to research, one of the most important factors in regulating the amount of indoor air pollution in air-conditioned office buildings is the occupant density of the space. Considerable amounts of various air pollutants (PM2.5, PM10, PM1, CO_2, HCHO and TVOC) were noted in each of the four buildings included in the current investigation. Furthermore, PM2.5, PM10, PM1 and CO_2 concentrations in the all-office buildings were significantly lesser than its standards limitations which may be attributed to the type of activities that took place in the office buildings, especially good cleaning activities and less no. of visiting people in the offices.

ACKNOWLEDGMENTS

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Hemina Z Patel and Neeraj D Sharma
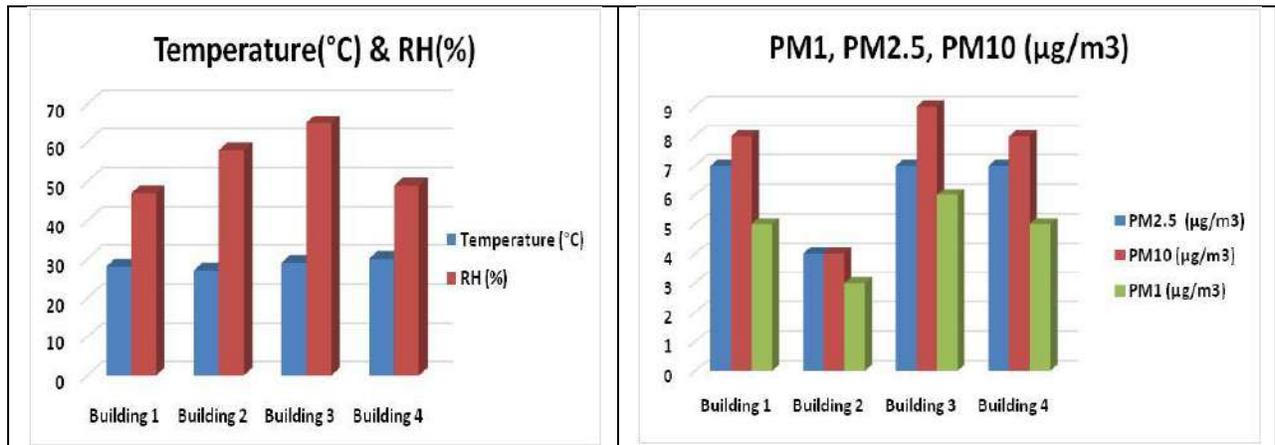
Figure 1: Temperature and Relative Humidity

Figure 2: PM₁, PM₂.₅ and PM₁₀Concentration
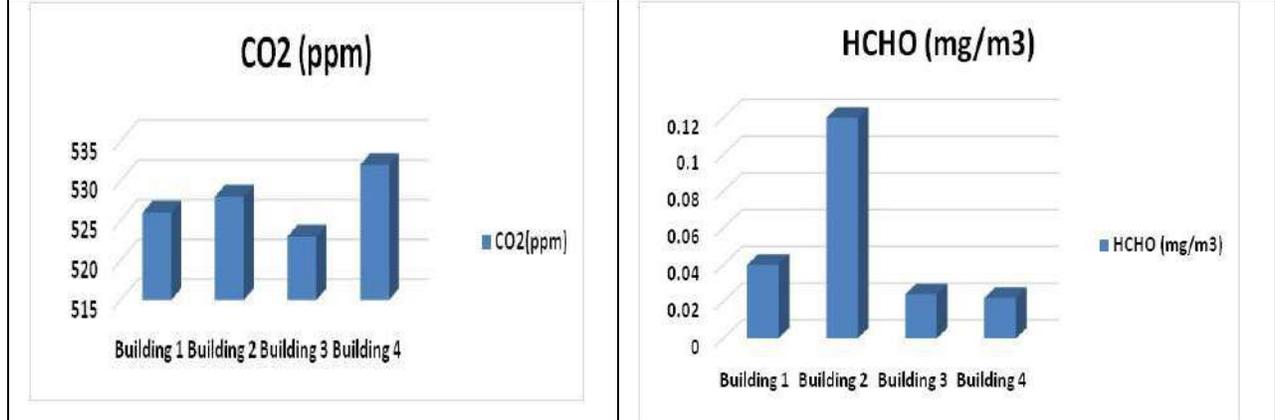
Figure 3: CO₂ Concentration

Figure 4: HCHO Concentration
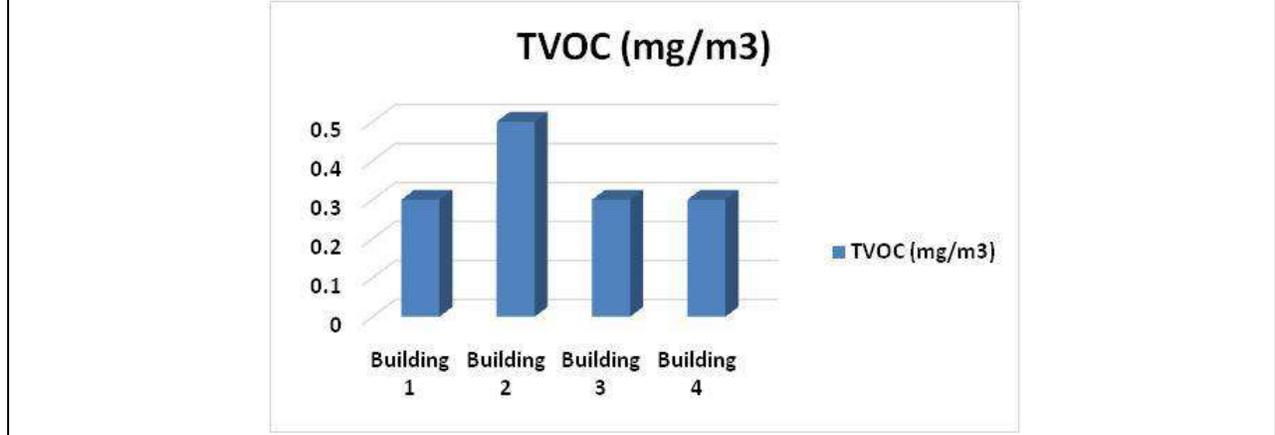
Figure 5: TVOC Concentration

RESEARCH ARTICLE

On the Suitability of Two Different Pulses for UWB Indoor Localization

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ABSTRACT

Indoor localization system (ILS) is the method of finding out the position of the object, people, and equipment etc in the indoor area system. The ultra-wideband(UWB) system is a favourable solution for high data rate in wireless communication for the purpose of Localization. The UWB transmission scheme proposed two major approaches that are single band approach and multiband approach. Here in this paper, the two pulses(Gaussian and Rectangular) are taken into consideration for ILS. Both these two received pulses under go the operation of averaging and correlation with that of the original transmitted signal for getting the time of arrival (TOA)data in order to locate the position of target in the indoor area system.

Keywords: ILS, Localization, TOA, UWB, Correlation

INTRODUCTION

Now a days the utilization of wireless communication increases rapidly,so the requirement of high data rate also increases,for this there is a need increased data rate capacity, which can satisfy the user's demands fruitfully.The data rate can be increased by increasing the signal bandwidth.The ultra-wideband (UWB) is a type of wireless technology, which plays a vital role in the field of localization for its several features like wide spectrum that is the frequency range is 3.1GHz-10.6GHz, the duty cycle is very less that is maximum on time 5ms to off time 38ms, the ranging accuracy is very high (cm), the pulses used are very small (ns), ability of penetration to the obstacles, capable of avoiding the multipath fading etc. The Federal Communications Commission (FCC) has assigned (In February 2002) the spectrum in range 3.1 GHz - 10.6 GHz as unlicensed indoor UWB application and also defined as this signals having -10 dB bandwidth is higher than 500 MHz [1-4]. Generally the UWB transmitters operate by dispatching billions of pulses through a large spectrum having 7.5GHz wide bandwidth. Modern UWB systems use two technical proposals, one is divide the total of 7.5 GHz spectrum through some 528 MHz bands, which allows the

proper execution of bands in definite frequency ranges, on the other hand leaving the rest portions of the spectrum remain unused and other is introducing OFDM modulation scheme and is referred to as UWB-OFDM or multi-band orthogonal frequency division multiplexing (MB-OFDM), which can be contemplated as strong applicant for high-speed WPAN standardization, which come up with high data rate without ICI and ISI technology[5-8]. In this technique, due to the overlapping of sub channels, hence the transmission rate also increases. The requirement of modulators and filters at the transmitter side and similarly the demodulator and complementary filter at the receiver side can be reduced by advanced digital signal processing applications like implementation IFFT and FFT method for modulation and demodulation operation, which make the system more efficient [9].This paper includes the Gaussian pulses and Rectangular pulses for finding out the channel area for the purpose of localization in Indoor area system. The main objective is to look over the distance value for localization in Indoor area system by considering the Gaussian pulse and Rectangular pulse signal in a typical Indoor area system. The distance of a target is estimated by the time of flight (ToF) calculation that can be obtained from a correlation receiver and use this information to identify the channel type the device is operating in.

LITERATURE SURVEY

The ultra-wide band communication technology acts as an emerging technique for the high data rate, low range wireless communication. The UWB transmission scheme proposed two major approaches that are single band approach and multiband approach. Each approach has some merits and demerits .To nullify the limitations of single band technique the multiband were taken into consideration. In this technique rather than taking the total spectral range of UWB for transmission of the information, divide the UWB band in sub bands. Each of the sub bands takes a range of bandwidth of more than 500 MHz. the information has transmitted through the different sub bands at different instant of time. The main advantage of multiband approach is information has to be operated on a very small range of bandwidth [10-12]. The multi band OFDM UWB proposal given by IEEE802.15.3a standard, the whole spectrum split into 14 number of sub bands having 528 MHz of bandwidth shown in fig. 1. All of these sub bands uses OFDM modulation for the transmission of the information. These 14 sub bands are combined in five groups named by group A, B, C, D and E. The 3 initial sub bands with spectrum of 1.8GHz (3.1GHz-4.9 GHz) are called mandatory mode or group A shown as in fig. [13-14]. As the MB-OFDM Signal is generated by Rectangular pulse signal, but its spectrum includes the side lobes, which may create interference in IPS. On the other hand a Gaussian waveform is a bell shaped function and is normally distributed with equal number of measurement with respect to its mean value (upper and lower of mean). Its spectrum does not contain any side lobes; hence this signal is immune to interference in the area of localization. It can also be used for clustering, that is a set of data points can be grouped into a cluster and it allows an efficient calculations in statistical analysis. So we simulate here both Rectangular pulse and Gaussian pulses to carry out the operation of localization in Indoor area system.

Proposed System Model for TOA (Time of Arrival) Estimation

The proposed system to investigate the suitability of these two different pulses is shown in Fig.2. Here, a UWB transmitter generates very short duration pulses that are passed inside indoor area channel. In the Receiver section the UWB receiver processes the transmitted signal along with noise. To remove noise at the receiver side, the average of the noisy signal is taken into consideration and it is passed through the correlation block, where the operation of correlation is performed between the received signal with that of the referenced signal. Now the output is passed through a peak detector, which determines the information about To A of the UWB signal for Localization in Indoor area system. The UWB simulation parameter values to study the suitability of the rectangular pulse and the Gaussian pulse are listed in Table-1. The simulation is done using MATLAB. Fig.3 represents the Gaussian pulse simulation. In Fig. 4, the convolution operation is done in between the UWB signal and that of the channel. After that the transmitted signal is added with noise as shown in Fig.5. Now the noisy signal is delayed as shown by Fig.6. In Fig.7, it represents the Averaging operation at the Receiver side. Finally the peak detection occur by the operation of correlation, the peak detection occurs at 600numbers of samples as shown in Fig.8, the 600 samples correspond to a ToA of 10ns. This results in a ranging of 3m. These results correspond to a channel type primarily of the CM2 (0 to

4mt with NLOS), the ranging information so obtained is used further to locate the coordinate of target unit in the area of localization.

Simulation Result for Rectangular Pulse Signal

Fig.9 represents the Rectangular pulse simulation. In Fig. 10, the convolution operation is performed between the rectangular signal and that of the channel. After that the transmitted signal is added with noise as shown in Fig.11. Now the noisy signal is delayed as shown by Fig.12. In Fig.13, it represents the Averaging operation at the Receiver side. Finally the peak detection occur by the operation of correlation, the peak detection occurs at 1000numbers of samples as shown in Fig.14, the 1000 samples correspond to a ToA of 16.66 ns. This results in a ranging of ranging 5m. which corresponds to a channel type of the CM3 (4 to 10mt with NLOS).

CONCLUSION AND FUTURE WORK

This paper analyzes the Gaussian signal and Rectangular signal for finding out the time information, which is required for estimating the Indoor area for UWB localization.From the different output results, it is come to an end that the simulated output for Gaussian pulse represents a smooth representation of distance estimation, but the range of area for experimentation is low. On the other hand the estimated distance for localization using Rectangular pulse increases, but its output representations signifies slightly complex delegation. Further, a Gaussian pulse is more suitable for a CM2 channel while CM3 channel type is better served by a rectangular pulse. The future work is to carry out the localization in indoor area system through these distance values by the application of machine learning techniques.

ACKNOWLEDGEMENTS

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Table 1: UWB Simulation Parameters

Simulation Parameter for UWB	Value
Light Speed	3×10^8 m/s
Shape of pulse	Gaussian, Rectangular
SNR	30dB
Sample rate	60GHz
Pulse width	0.5ns
Number of samples	1000
Variance	0.2
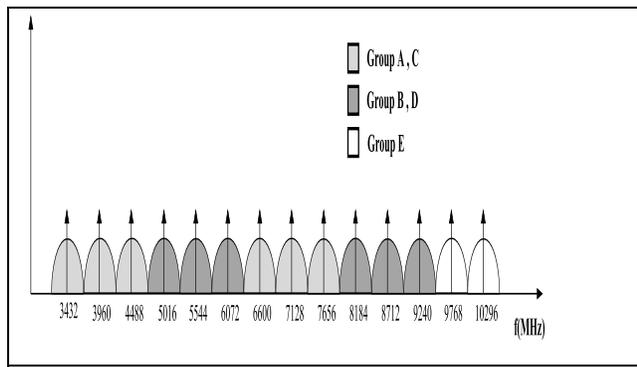
Fig. 1 Band planning structure for the MB OFDM system	Fig.2 Block diagram for UWB Simulation system[15]
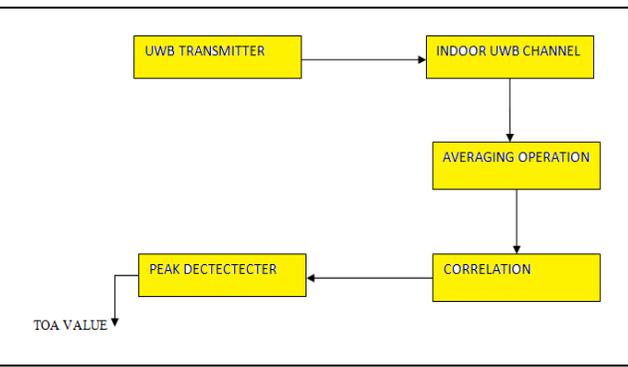
Sujata Mohanty and Aruna Tripathy
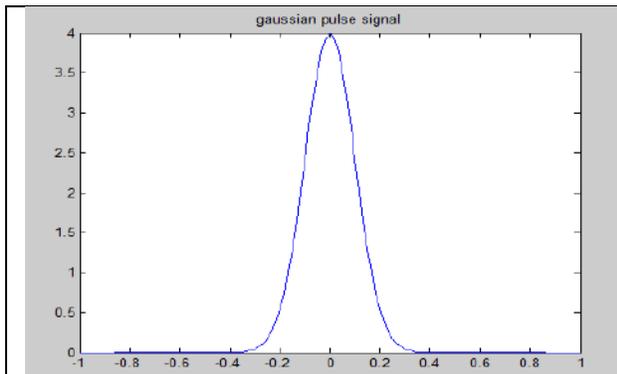
Fig.3 Gaussian Pulse Signal
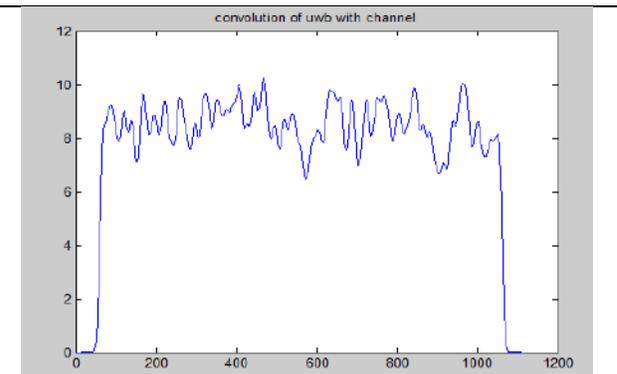
Fig. 4 Convolution of UWB with Channel
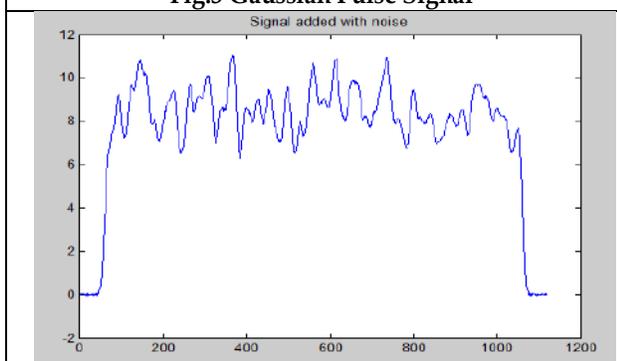
Fig.5 Signal added with Noise
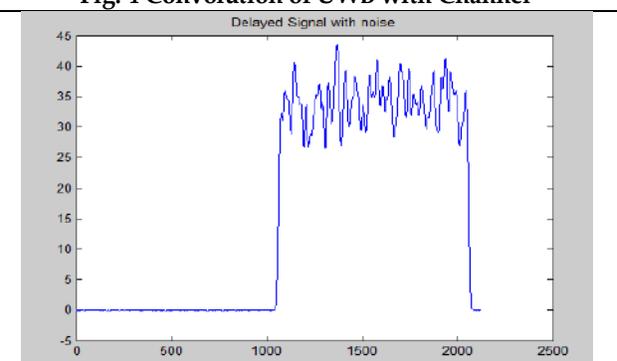
Fig.6 Delayed signal with Noise
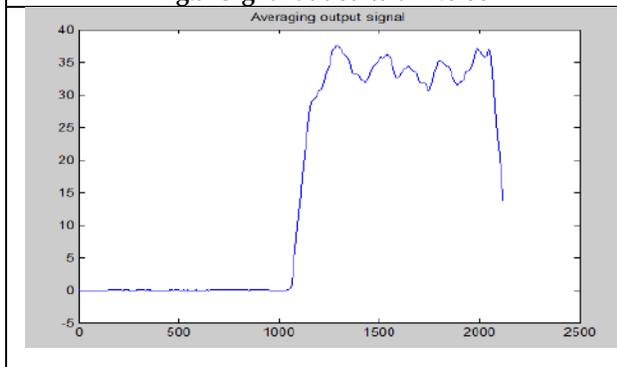
Fig.7 Averaging output Signal
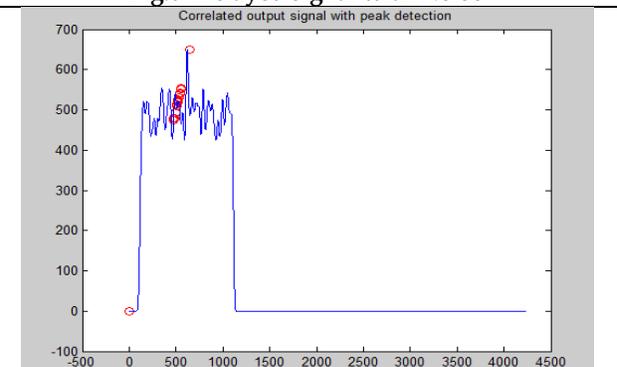
Fig.8 Corelated output signal with peak detection
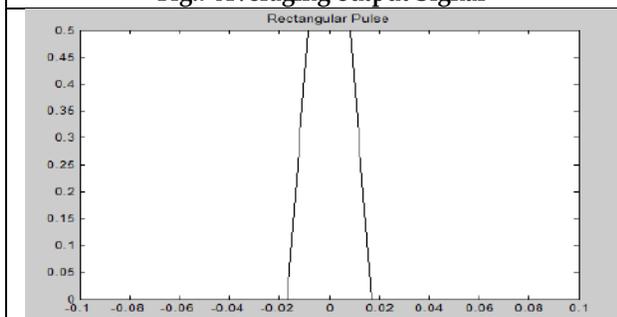
Fig.9 Rectangular pulse signal
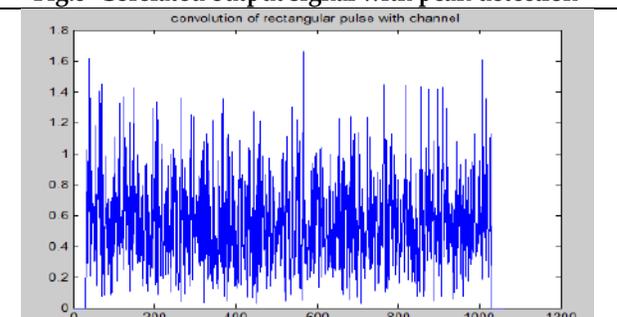
Fig.10 Convolution of rectangular pulse with channel

Sujata Mohanty and Aruna Tripathy
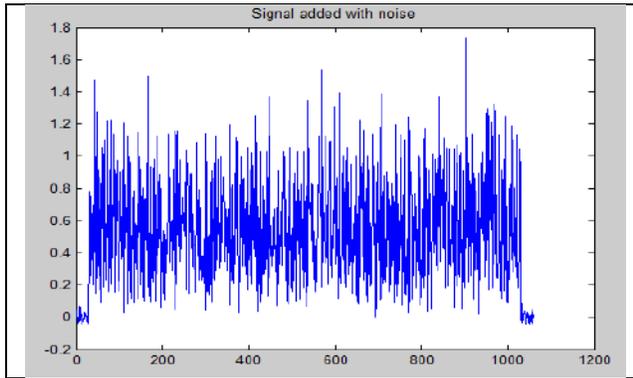
Fig.11 Signal added with Noise
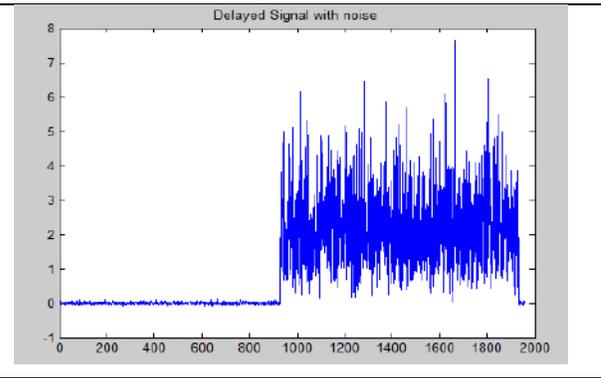
Fig.12 Delayed signal with Noise
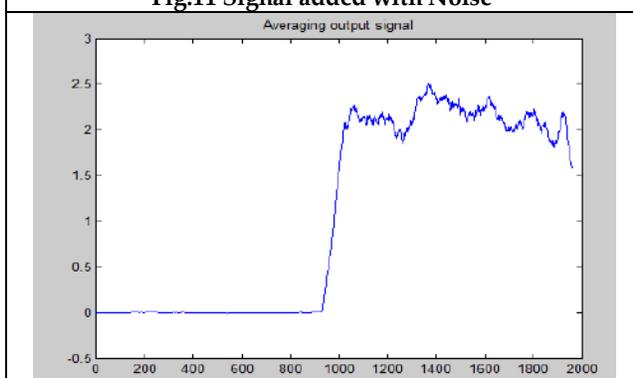
Fig. 13 Averaging output Signal
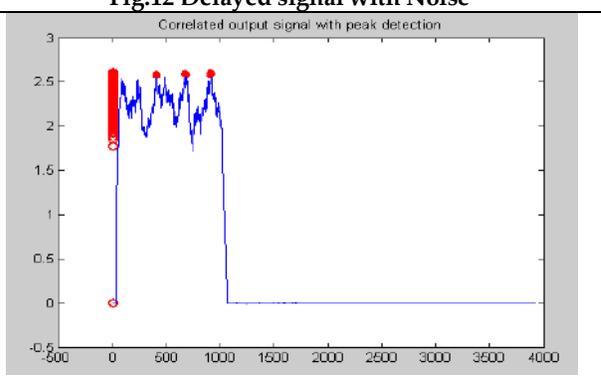
Fig. 14 Corelated O/P for Rectangular signal

REVIEW ARTICLE

Applicability of Machine Learning Algorithms in Drug Formulation – A Literature Review

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ABSTRACT

Artificial Intelligence (AI) is an emerging field with the potential to enhance various processes and outcomes. AI, particularly Machine Learning (ML), can simulate human-like thinking and intelligence through artificial systems. Within AI, Machine Learning involves creating models using data. In the pharmaceutical industry, drug formulation is a complex and resource-intensive process. AI, especially ML, offers a solution to streamline this process by optimizing cost, time, and accuracy. AI tools can be applied to catalyze drug formulation. Machine Learning algorithms can predict drug permeation through the skin, aiding the selection of optimal drug-delivery system combinations. ML can optimize transdermal formulation design by identifying the best mix of ingredients and delivery methods for desired therapeutic results. By analyzing data on drug properties, skin physiology, and more, ML expedites formulation development, reducing time and costs associated with traditional trial-and-error approaches. Machine Learning models can predict potential adverse effects of drug permeation and recommend formulations for improved efficacy and safety. Recent research has shown various machine learning algorithms, including Artificial Neural Networks, Convolutional Neural Networks, and Random Forest, being used for drug formulation optimization over the past decade. This highlights the current importance of AI in pharmaceutical research and its potential to reshape drug development.

Keywords: Algorithm, Machine Learning, Artificial Neural Network, Supervised Learning, Unsupervised Learning, Drug Formulation.

INTRODUCTION

This review focuses on the vital role of Artificial Intelligence (AI) in modern drug formulation research. It addresses the lack of a thorough exploration of machine learning's impact on this field. Through exploring algorithms, methodologies, and accomplishments, the review aims to reveal the true potential of AI in drug formulation. AI's roots extend to the 1956 Dartmouth Conference, led by John McCarthy, setting the stage for exploration. Advancements emerged in the 1970s-80s with human-like decision-making, while 1986's neural network breakthrough propelled AI. IBM's 1997 Deep Blue victory over Kasparov marked a pivotal AI-human milestone. The real catalyst for AI's advancement came with Machine Learning (ML). Unlike early AI, which followed fixed rules, ML combined computer science and statistics, triggering a new era. Algorithms began learning and adapting, surpassing rule-based constraints. This shift led to remarkable AI improvements, where data became the vital resource for effective learning. In today's data-driven age, copious information is produced daily in various sectors, including pharmaceuticals. Data quality is crucial for gauging drug effectiveness and safety. Big data analysis is vital, revealing chemical traits, drug performance, and their therapeutic or harmful effects on patients. Patient-specific data, such as age, gender, weight, and doses, further enhance our grasp of drug impacts. The use of machine learning in drug formulation has the power to revolutionize the process. By leveraging vast data and adaptable algorithms, it aims to expedite drug development, improve formulation accuracy, and cut costs. This review delves into existing literature and algorithms to deeply analyze the progress achieved in merging machine learning and drug formulation.

Machine Learning
Machine learning is a branch of AI that employs data and algorithms to mimic human learning and enhance accuracy. ML trains machines to efficiently manage data using algorithms, enabling computers to decide and generate patterns within specific contexts.

Machine Learning Types
Machine Learning involves non-living entities learning from data to provide specific predictions. Algorithms process and understand data, a process known as "training a model."Víctor Gallego [1] discussed the utilization of diverse machine learning algorithms to forecast drug development through AI; however, there remain opportunities for enhancing the prognostic accuracy in this domain. Given the abundance of data, there's no universal approach for managing unique datasets. Machine Learning addresses this through its various types, as follows:

Supervised Machine Learning
Here, the machine learning takes place in a supervised manner. In other words, we know what the output will be for the input we provide. This type of machine learning is generally preferred when the dataset is clear and labeled. I.e. the dataset is more in a structured format. Supervised learning is categorized in two different types, depending on the outputs: Classification: This type of learning is used when the expected output can be categorized into distinct results like a specific colour, name of a city, a specific education branch, a gender etc. Sub parts of this learning method are as below: Random Forest Algorithm creates decision trees through multiple rounds of random subset selection from the dataset. These subsets generate new trees, and their predictions are merged for the final result. Decision Tree Classification is a machine learning method that constructs a tree-like model to make decisions from input data. It's widely used for classification and regression. The technique divides the dataset into subsets by analyzing input features, forming a tree. Internal nodes decide using features, while leaf nodes denote class labels/outputs. It's user-friendly, interpretable, and suits numeric/categorical data. Yet, it may over fit intricate data. Logistic Regression Algorithm is a core machine learning method for binary classification. Despite its name, it focuses on classification, not regression. It predicts the likelihood of an input belonging to a class by using the logistic function on input features. This transforms the output into a probability between 0 and 1, with values above 0.5 indicating the positive class and below as the negative class.

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Logistic Regression is a simple, interpretable, and efficient method, ideal for scenarios with roughly linear input-target relationships. Yet, it could face challenges with intricate data patterns needing more advanced algorithms. To counter over fitting and boost results, techniques like L1 and L2 regularization can be employed. Support Vector Machine(SVM) is a potent machine learning algorithm for classification and regression tasks. It seeks the optimal hyper plane to separate classes in data by maximizing their margin. SVM transforms input data into a higher-dimensional space to find this hyper plane, making it adept at handling intricate relationships and various data types through kernel functions. Its strength lies in achieving robust generalization on new data, especially in high-dimensional scenarios or when distinct class boundaries are crucial. Run Han [2] et al. have developed a novel prediction model using Random Forest (RF) algorithm, for the physical stability of solid dispersion formulations using machine learning techniques. This improved maximum dissimilarity algorithm (MD-FIS) model has achieved 82.5% accuracy, among the other eight machine learning approaches. Regression: This type of learning is used when the expected output is not distinct but rather continuously changing values like weather prediction, price variation in real-estate sector, sales trends in a company etc. Sub parts of this machine learning are Simple Linear Regression Algorithm, Multivariate Regression Algorithm, Decision Tree Regression, Lasso Regression

Decision Tree Regression algorithm uses a tree-like model with a root node, intermediate nodes, and leaf nodes. It divides data into smaller subsets based on feature values through recursive splitting. Each split preserves important data or minimal impurity. Splitting halts, when a stop criterion is met. When the tree is built, new data traverses nodes from root to leaf, selecting branches based on node values. Predictions rely on majority matches or calculated average values. Pauric Bannigan [3] et al. has created a tree based Light Gradient Boosting Machine (LGBM) model. This model has provided the most accurate prediction accuracy with MAE values of 0.125 and 0.114, for the inner and outer loops, respectively for fractional drug release in long-acting injectable in comparison of other eleven ML algorithms. The LGBM model afforded the narrowest distribution in absolute error values for the test data. As per G.P. Moss [4] the study compares discriminant analysis (DA) and various machine learning methods for classifying chemical enhancers of percutaneous absorption and predicting enhancement ratios (ER). DA provided reasonable classification accuracy but lacked consistent ER estimates. Machine learning, including Gaussian process (GP) regression and K-nearest-neighbor (KNN) regression, improved ER prediction accuracy. The SVM classifier with oversampling achieved the best classification result, while GP yielded accurate ER estimates for both strong and weak enhancers. Machine learning methods offer enhanced classification and prediction abilities compared to discriminant analysis, facilitating more accurate and reliable assessment of enhancer characteristics and capabilities.

Unsupervised Machine Learning
Unsupervised learning doesn't need supervision or labeled data. It's used for unclassified data. The model trains without supervision, grouping data into categories, patterns, etc. Subcategories include: **Clustering**: This unsupervised technique groups similar data together, forming clusters based on shared behavior. For instance, it can identify popular food items or common OTC medicines for headaches. Clustering includes various types as well like K-Means clustering, Mean-shift clustering, DBSCAN algorithm, Principal Component Analysis, Independent Component Analysis **Association**: This unsupervised learning technique; find the relation between the entities in the large dataset. It then finds the dependency or link of one entity with the other and then maps them to optimize the output. A common example of association is optimizing in-continuous production. Association can be classified into different types viz. Apriori Algorithm, Eclat, FP-growth Algorithm.

Semi-supervised Machine Learning
This technique, called semi-supervised learning, optimizes the use of mixed labeled and unlabeled data. Solely relying on supervised learning may lead to discarding unlabeled data, while using only unsupervised learning risks losing labeled information. This algorithm addresses this by first applying unsupervised learning to form clusters from unlabeled data. These clusters then help label the unlabeled data, resulting in an augmented dataset that's larger in labeled samples without sacrificing its original size.

Laura E [5] is the first one who has applied emerging machine learning technique, active ML to micro biome science. Active ML predicts how excipients at pharmaceutically relevant concentrations affect the intestinal proliferation of a common probiotic, Lactobacillus paracasei. The average certainty of the final model was 67.70% and experimental validation demonstrated that ¾ excipient-probiotic interactions could be correctly predicted. Traditional ML techniques, such as ANN and tree-based methods, require large datasets, while active ML can be employed as a tool for small datasets for accurate in silico predictions.

Reinforcement Machine Learning
Reinforcement learning involves strengthening a model by rewarding successful actions. Imagine a person learning from mistakes and self-rewarding upon achieving goals. For instance, a computer playing a video game learns by rewarding itself for positive moves against opponents and aiming to enhance its gameplay.

Artificial Neural Network
Artificial Neural Network is a part of machine learning which resembles with the neural network found in human brain, generally known as Biological Neural Network. The strong part of ANN is that is does not need an explicit program but it learns from the data rather. The delta between the predicted output and actual output is reduced by changing the factors viz. weights and biases. These cycles of training goes on till the network is able to generate an accurate output for the new test data. As ANN learns from its data, the drawback of this type of learning is that it needs a very large set of data to reach accuracy. Handling such a large set of data also needs an expensive hardware resource, which actually is not a challenge now days. Hao Lou [6] has reviewed the commonly used machine learning algorithms in solid oral dosage form development. These machine learning algorithm were written using known programming languages like Python, Java, R etc. The software used to run these algorithms could be SAS, JMP, MATLAB, WEKA etc. According to the review, it is ANN which is extensively used since last few years esp. from 2015 to 2019. The count of the published paper during this period was more than 30. The statistical data mentioned in the review that around 67% of algorithm used was ANN. While remaining 33% of algorithm were other machine learning algorithm. Manoj Kumar Ananthu [7] have reviewed that how ANN algorithms are more benefitted over mathematical method of RSM, to optimize different pharmaceutical formulations. They developed a multi-objective parallel optimization strategy to overcome the limitation of RSM using ANN.

Junhuang Jiang [8] has concluded that In pharmaceutical research, ANN models have been effectively employed to optimize transdermal drug delivery formulations. These models accurately predict response variables and demonstrate good agreement with experimental results. Furthermore, neural networks are integrated with other techniques like Gaussian mixture models and quantitative structure-property relationship models to develop intelligent systems for predicting drug release profiles. This approach shows promise for enhancing transdermal drug delivery optimization and prediction processes. Shan Wang [9] has discussed the advanced role of artificial neural networks (ANNs) in pharmaceutical research. ANNs are explored as powerful tools for predicting, characterizing, and optimizing various aspects of pharmaceutical formulation. This review highlights the application of ANNs in modeling complex relationships within formulation data, enabling accurate predictions of formulation properties, and facilitating optimization processes. The abstract emphasizes the significance of ANNs in advancing pharmaceutical formulation techniques and their potential to enhance efficiency and precision in drug development. According to Hao Lou [10] the study investigates enhancing powder compactability using the core/shell technique through systematic experimentation. A Design-of-Experiment (DoE) is conducted to evaluate the effects of core and shell materials on strength and brittleness. Various machine learning algorithms, including RSM, SVM, and different ANN types, are utilized to model relationships between product outputs and material inputs. Results indicate improved compatibility with core/shell approach, and all algorithms demonstrate predictability and generalization, with ANNs handling complex patterns effectively. These models unveil and visualize relationships between product profiles and material attributes. Nitin S. Parmar [11] reviewed the utilization of artificial neural networks (ANNs) as a powerful technique in optimizing controlled release drug delivery systems, surpassing limitations of response surface methodology (RSM). ANNs simulate human brain processes to process information, learning from patterns in data rather than being programmed. The review covers the basic structure and development of ANN models for

controlled release formulations, emphasizing the impact of neuron transfer functions, learning rules, and architecture. Applications of ANN in pharmaceutical sciences, from interpreting analytical data to drug and dosage form design, are explored, highlighting its wide potential in enhancing various aspects of controlled release drug delivery.According to Parichehr Hassanzadeh [12] this abstract highlights the application of artificial neural networks (ANNs) in optimizing transdermal hydrogel formulations for drugs like ketoprofen and melatonin. For ketoprofen, an ANN model was developed to optimize gel composition, with the optimal formulation matching the model's predictions. ANNs and response surface methodology (RSM) were employed to optimize the composition of a transdermal vehicle for melatonin delivery. The focus was on enhancing melatonin flux and reducing lag time through solvent mixtures. A multi-layer feed forward back propagation network identified suitable solvent mixtures and assessed inter-relativity between responses, with experimental results aligned with predictions. A screening algorithm integrating neural networks, genetic algorithms (GAs), and structure-property relationship models was developed to identify chemical penetration enhancers for transdermal drug delivery. The algorithm, validated with melatonin permeability and toxicity assessments, demonstrated potential for enhanced skin permeation enhancer development.

Convolutional Neural Network

CNN is a deep learning algorithm for image/video detection. It uses layers of neurons to extract info from data, leading to predicted output. Current capsule defect detection relies on slow, error-prone human assessment. An automated system would enhance accuracy and speed. Junlin Zhou [13] proposed a new capsule detection algorithm that is based on improved CNN, where the qualified and defective capsule images are collected from an existing production cycle. Now deep learning model based on improved CNN is trained to identify the defective and qualified capsule. This new improved CNN algorithm is named as RACNN. Where RA stands for Regularization and Adam optimizer. The Adam optimizer is used to increase the model training. The parameters used to tune this algorithm are 'batch size' and 'learning rate'. By adjusting these parameters the best combination achieved has an accuracy of 97.56% which makes this model concise and efficient enough to identify defective capsules from the production cycle. Xiangyu Ma [14] have developed a tool using deep learning convolutional neural networks which detect internal crack detection of oral tablets through XRCT images, with an average accuracy of 94%. The deep learning tool is fully automated and capable of analyzing hundreds of tablets. According to Aliasgar F Shahiwala [15] machine learning approach employs optimize drug formulations, utilizing a neural network model to predict particle size and drug entrapment for niosomes. The model achieves high prediction accuracy, highlighting key factors affecting these properties. The network showed the highest prediction accuracy of 93.76% and 91.79% for % drug entrapment and particle size prediction. Validation with experimental batches demonstrates the superiority of the neural network over response surface methodology, emphasizing its potential for designing effective drug niosomal formulations. S. Agatonovic-Kustrim [16] has proved that using back-propogation ANN has achieved 84.5% accuracy in protein recognition in protein side-chain-side-chain contact maps.

Machine learning tools

In the previous topic, we emphasized the types of machine learning algorithms. Pauric Bannigan [17] et al. has stated about readily availability of large number of machine learning algorithm via well-established libraries and software packages. To use these algorithms, there are some tools available in the market. Below is the list of widely used tools:

Weka

WEKA (Waikato Environment for Knowledge Analysis) is well-known open-source software for machine learning and data mining. It offers a user-friendly interface and a variety of algorithms for tasks like data preprocessing, classification, regression, clustering, and association rule mining.

Tens or Flow

It is, an open-source ML framework by Google, is popular for creating diverse deep learning models, using data flow graphs for efficient computation. It's favored by researchers for scalability, distributed support, and cross-platform deployment, covering image recognition, NLP, and more.

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Py Torch

It is, an open-source machine learning framework from Facebook's AI Research lab, stands out for its dynamic computation graph system, offering intuitive and flexible model building unlike static graph frameworks. It's popular for neural network development, seamlessly integrating tensor computations and automatic differentiation. Researchers favor PyTorch for its user-friendly experimentation, aided by its dynamic nature, easing debugging and prototyping.

Scikit Learn

Scikit-Learn, or sklearn, is a widely used open-source Python library for machine learning. It provides efficient tools for data analysis and mining, offering algorithms for classification, regression, clustering, dimensionality reduction, and more. With a user-friendly API, it suits both beginners and experts, seamlessly integrating with popular libraries like NumPy, pandas, and Matplotlib.

Amazon Machine Learning

It is provide by Amazon Web Services (AWS) is a cloud service that lets users easily create, train, and deploy machine learning models without extensive expertise. It streamlines predictive model development for tasks like fraud detection, customer churn prediction, and demand forecasting.

Steps involved in machine learning

Like any other complex activity, machine learning seems to be a difficult ride, but it actually is simple if the principal of – divide and rule. Let's see how we can divide the whole activity into different steps:

Data Collection

The key to a successful machine learning algorithm is the prime ingredient: accurate predictions. Achieving high accuracy relies on quality data. It must originate from valid, reliable sources, be free of redundancy and missing values, and exhibit clear patterns or clusters.

Data Preparation

Even after making immense efforts it is inevitable to get a perfect set of data. Thus whatever data is collected that needs to be prepared in following manner Remove redundant information, Remove unwanted data, Remove missing values, Converting data types, Grouping into patterns/cluster, Split – Test dataset & Training dataset

Model Selection

The data is prepared, but knowing its type and our goal is crucial. Understanding this aids in selecting an appropriate model for improved predictions. Various industry models can align with your measurements.

Model Training

This model enhances prediction, much like human improvement through practice. By training it with diverse datasets, its predictive prowess improves.

Model Evaluation

During training, the model processed the test dataset and matured. With training complete, it's now time for evaluation. The test dataset is applied to the model to assess its performance with this fresh data.

Parameter Tuning

After evaluation, improving model accuracy becomes the focus. By adjusting data characteristics, parameter tweaks can enhance accuracy, though excessive tuning might harm performance. Balancing these factors requires managing trade-offs.

Predictions
Once you collect and prepare the data, select, train, evaluate, and tune the model for the highest accuracy, it is time to do final predictions.

APPLICATION OF MACHINE LEARNING IN TRANDERMAL DRUG FORMULATION
The traditional drug formulation lacks modern software-based decision-making. Termed "conventional method," it lacks software integration yet remains crucial in understanding drug formulation. Choosing a drug's administration form (injections, tablets, patches) is a key consideration, determined by its unique properties. While maintaining quality, this method has drawbacks: trial and error, high resource and time costs, affecting drug cost, production, and efficiency in commercialization. In Table 1, we summarize the use of machine learning in transdermal formulation.

Future Perspective and Challenges
At present, the Artificial Neural Network algorithm is commonly used in pharmaceutical science mainly includes the multilayer perceptron, generalized regression neural network etc. while in future advances in optimization algorithms, model design and upstream disciplines will improve the performance of ANNs. [18]
Machine learning is making its mark in the pharmaceutical industry, with a promising future in drug formulation as below:

Improved Drug: Not just patient-drug data, but also the vast information about chemical drugs and their biological effects can be analyzed to improve drug quality.

Drug Personalization: Tailoring drugs to individual impact based on patient's clinical history is achievable for maximum effectiveness.

Fast Drug Discovery: Assuming better data access from various sources, drug discovery can improve, cutting costs and risks linked to conventional methods. Drug Quality Integrating machine learning into the production chain enables consistent drug quality, controlled impurities, and improved production cycles. Despite its promising benefits, machine learning also presents intriguing challenges, outlined below:

Insufficient Data: Data is crucial for machine learning. In some cases, there might be insufficient or limited data, making it challenging to train models effectively.

Quality of Data: If a dataset is available, the next challenge is its quality, concerning variety, accuracy, drug properties, etc. Large data simply does not guarantee a better-trained model, if the quality of the data is not as expected.

Over & Under Fitting: If a complex model trains on limited data, it predicts broadly, causing Data Over-fitting. Conversely, a simple model trained on complex data yields irrelevant conclusions due to insufficient information extraction.

High-dimensional modeling: Studies should perform appropriate feature engineering, feature selection and dimensionality reduction. [19]

Regulatory Limitations: Drug formulation requires adherence to strict norms and guidelines. The machine learning model must comply with these limits, providing clear and industry-accepted predictions.

CONCLUSION

This review underscores the critical need to improve transparency, reliability, and accuracy in machine learning (ML) models within the realm of drug formulation. While acknowledging that optimal methodology is just one aspect of a broader narrative, the integration of expertise from drug formulation scientists and empirical data from both in vivo and in vitro experiments with ML-generated predictions is suggested to address uncertainties throughout drug product development. Envisioning a future where computers guide the entire process, there is a prospect of realizing an end-to-end *in silico* approach for generating medicines from diseases through ML. The literature consistently highlights the significant contributions of ML techniques in various aspects of drug formulation, such as design streamlining, property prediction, and controlled drug release, thereby enhancing overall product performance. Diverse algorithms, ranging from neural networks to support vector machines and Gaussian processes, are employed to address intricate challenges. Despite the promises, ongoing research is pivotal to tackle concerns related to data quality, model interpretability, and validation across diverse compounds. In summary, the review underscores the transformative impact of machine learning on innovating drug formulation, with the evolution of technologies like fuzzy logic and genetic algorithms poised to further streamline drug design, formulation, and manufacturing processes.

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Table 1. Application of Machine Learning In Trandermal Drug Formulation

Research Paper	Algorithm	Pros	Cons
Liu et al. (2022) - "Machine learning-based formulation optimization for transdermal drug delivery"	Random Forest, Genetic Algorithms	Efficient screening of formulation variables	Vulnerability to noise in data; may require substantial computing resources
Zhao et al. (2021) - "A comparative study of machine learning methods in transdermal patch formulation optimization"	Support Vector Regression, Neural Networks	Improved model accuracy and reliability	Sensitivity to dataset size and quality; model training complexity
Wang et al. (2021) - "Prediction of in-vivo transdermal permeation using a machine learning approach"	Gradient Boosting, Bayesian Optimization	Enhanced prediction of transdermal permeation	Dependency on accurate experimental data; model complexity
Zhang et al. (2020) - "Transdermal patch formulation optimization using a machine learning approach"	Genetic Algorithms, Support Vector Machine	Efficient identification of optimal formulations	Relies on available data quality; potential model bias
Tan et al. (2020) - "Machine learning-guided optimization of transdermal patch formulations"	Genetic Algorithms, Bayesian Optimization	Reduced experimentation time and cost	Need for comprehensive and accurate experimental data; potential model limitations

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Liao et al. (2019) - "Formulation optimization of transdermal patches using machine learning"	Artificial Neural Networks	Rapid exploration of transdermal formulation space	Requires substantial initial dataset; complex model interpretation
Patel et al. (2019) - "Formulation optimization of transdermal patches using machine learning techniques"	Decision Trees, Artificial Neural Networks	Reduction in trial-and-error iterations	Limited by available training data; model generalization challenges
Kim et al. (2019) - "Formulation optimization of lidocaine transdermal patches using machine learning techniques"	Decision Trees, Gradient Boosting	Rapid identification of effective formulations	Dependence on available formulation data; potential model bias
Chen et al. (2018) - "Machine learning-based formulation design for transdermal patch: A case study of a rotigotine patch"	Random Forest, Particle Swarm Optimization	Streamlined optimization process	Sensitivity to training data representativeness; potential model overfitting
Zhang et al. (2017) - "Machine learning approach for formulation design of transdermal patches"	Support Vector Machines, Neural Networks	Precise prediction of patch performance	Complexity in data preprocessing; model interpretability challenges

RESEARCH ARTICLE

Promoting Technological Advancements In A Non-Invasive Manner To Facilitate Mental Health Services For Women: A Comprehensive Study

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ABSTRACT

The field of clinical psychology requires a thorough investigation in order to effectively diagnose women with sadness and anxiety. Therefore, the use of Artificial Intelligence and Machine Learning Techniques in the field of mental healthcare has the potential to generate substantial advancements, enabling comprehensive preventive measures and management of depression symptoms especially for women. Therefore various hybrid models have been proposed as a means to mitigate risk of depressive symptoms. The rationale for this observation is in the greater influence of social and economic variables on females relative to males. The effects linked to this phenomena might manifest as both immediate and potentially long-lasting. Various factors such as postpartum depression, gender bias, genetic complexity in shared and non shared environment which can be natural or conventional, widowhood, adulthood, separation, loneliness, single marital status and posttraumatic events which may affect mental state of woman. The study focuses on the application and integration of various machine learning methodologies, including LSTM (Long Short Term Memory), Bi-Directional LSTM (BiLSTM), Local Interpretable Model-Agnostic Explanations (LIME)on Convolutional Neural Networks (CNNs), Deep Neural Networks (DNNs) and Recurrent Neural Networks (RNNs). The main objective of this study is to emphasize the identification of distinct indicators of depression in women and the capacity to process diverse forms of data within this domain, while integrating various components of Artificial Intelligence and Machine Learning.

Keywords: clinical psychology, Artificial Intelligence, LIME(Local Interpretable Model-Agnostic Explanations), Machine Learning, rationale.

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INTRODUCTION

Mental healthcare is a crucial element of holistic health and wellness, with a primary emphasis on the identification and treatment of mental and emotional health issues. The field of mental health covers a diverse array of services and interventions aimed at promoting and preserving mental well-being, preventing the onset of mental diseases, and offering support to individuals grappling with mental health challenges. The importance of mental healthcare within contemporary healthcare systems has gained growing recognition in recent times. It is imperative to recognize that mental healthcare does not adhere to a universal solution for all individuals. The treatment and support provided to individuals might exhibit significant variability in terms of their nature and duration, contingent upon their unique requirements and circumstances[1].The implementation of a comprehensive approach that takes into account the physical, psychological, and social dimensions of an individual's well-being and is frequently the most efficacious strategy for managing mental health issues. In recent times, there has been a notable acknowledgment of the significance of mental healthcare, accompanied by heightened endeavours to diminish the social disapproval associated with mental health concerns and enhance the availability of related resources[2]. Nevertheless, there are persistent issues that need to be addressed in the field of mental health. These challenges encompass discrepancies in the availability of healthcare services, the scarcity of mental health specialists, and the imperative for continuous education and heightened awareness. As societies undergo ongoing transformations, the field of mental healthcare will also progress, placing emphasis on enhancing the well-being of persons with mental health difficulties.

Symptoms of Mental Illness
As shown in fig.1. primary signs of depressive symptoms range over varied aspects of human body which give rise to mild, moderate and acute symptoms of depression.

Feeling anxious
Experiencing anxiety is a prevalent aspect of the human condition, encompassing a spectrum of emotions that span from a subtle feeling of discomfort to an overpowering state of apprehension and terror.

Digestive Problems
Digestive disorders, often referred to as gastrointestinal or GI disorders, involve a diverse array of illnesses that impact the functioning of the digestive system. The digestive system comprises a sophisticated arrangement of organs and physiological mechanisms that collaborate harmoniously to facilitate the breakdown of ingested food, assimilation of essential nutrients, and expulsion of waste materials. .

Dizziness and Fatigue
Dizziness and weariness are frequently encountered symptoms observed in individuals across diverse contexts, and can arise from a myriad of etiological factors.

Difficulty Sleeping
This prevalent sleep condition can significantly affect an individual's physical, mental, and emotional well-being, rendering it a subject of significant concern in the contemporary fast-paced and high-stress society[3].

Feminity Disorder
The presence of sexual dysfunction resulting from depression is a multifaceted and frequently distressing matter that can have a substantial impact on an individual's general well-being and intimate partnerships.

Low Energy
Individuals with depression may encounter a significant decline in their energy levels, leading to a perception of even basic chores as formidable obstacles. The absence of energy might further intensify the already profound emotions of sadness, helplessness, and worthlessness that are inherent to depression.

Grinding Teeth

Bruxism, sometimes referred to as teeth grinding, is a prevalent disorder that can be influenced or intensified by a range of variables, such as stress and sadness.

Menstrual Distress

The experience of monthly misery, commonly known as premenstrual syndrome (PMS) or premenstrual dysphoric disorder (PMDD), can be intensified by the presence of depression, resulting in an intricate interaction between mental and physical states of health.

Genetics

The etiology of depression is multifactorial, with genetic, environmental, and psychological variables all contributing to its manifestation. However, it is noteworthy that hereditary predisposition can exert a substantial influence on the development of depression[4].

Hypertension

Hypertension, also referred to as high blood pressure, is a complex medical disorder that can be impacted by a range of factors, encompassing lifestyle choices, genetic predisposition, and underlying health conditions.

Migraine

Migraines and depression are discrete medical diseases, albeit with potential interconnections that are intricate and multifaceted in nature. Although depression does not directly induce migraines, there exists much data indicating a robust association between these two conditions.

Rapid Heart Beat

Tachycardia, which refers to an elevated heart rate, can indeed manifest as a symptom or outcome of depression from a medical perspective.

Chronic pain

The association between chronic pain and depression is complex and bidirectional, with each illness often exacerbating or influencing the other. The concurrent presence of these two disorders can have a substantial impact on an individual's overall well-being.

Acne

Acne is a prevalent dermatological problem that can be influenced by a multitude of elements, encompassing hormone fluctuations, genetic predisposition, dietary patterns, and psychological stress. Although a clear causal relationship between depression and acne is not established, a multifaceted association exists between these two conditions, whereby depression might potentially contribute to the onset or aggravation of acne.

Mood Swings

The disorder is characterized by enduring emotions of melancholy, hopelessness, and a diminished engagement in previously pleasurable activities, with mood fluctuations being an additional prominent feature[5].

Clammy or Sweaty

Perspiration is an inherent physiological reaction aimed at maintaining thermal equilibrium and facilitating the dissipation of surplus heat, predominantly triggered by physical activity or elevated ambient temperatures.

Diabetes

This may be a pursuit of medical intervention for depression, the adoption of a health-conscious lifestyle, and the diligent surveillance of blood glucose levels in individuals with diabetes or those susceptible to its onset.

Furthermore, it is imperative for healthcare providers to take into account the potential interaction between depression and diabetes during the evaluation and management of patients.

Diarrhea

Diarrhea is a prevalent gastrointestinal disorder defined by the frequent occurrence of loose and watery stool motions. Although diarrhea is commonly attributed to physical factors such as infections, food poisoning, or nutritional problems, emerging research indicates that mental health disorders, such as depression, may also play a role in the onset or worsening of this ailment.

Factors affecting Women Mental Health
Gender Discriminability

Femininity and Masculinity are two sides of a socially balanced nationality. However, bias is still done on a false notion that women are weaker than men on the basis of physique and psyche. This falsehood is noted in society, at workplace and often upto some extent in healthcare diagnosis at various stages of womanhood like adult, postpartum, menopause amongst others. This bias can affect mental health of a woman which shows chronic signs of stress and if not detected and prevented timely can lead to acute stress[6].

Effect of Postpartum Depression in Women

Postpartum depression (PPD) is a significant mental health disorder that frequently elicits misconceptions, impacting a subset of women subsequent to childbirth. Postpartum depression, a variant of clinical depression, manifests within the initial year after childbirth, with a higher incidence observed within the initial three months postpartum. Postpartum depression (PPD) is a separate condition from the "baby blues," which is a less severe and more prevalent mood disorder experienced shortly after giving birth[7].

Genetic Factors responsible for Depression

The gene responsible for maintaining level of serotonin is 5-HTTLPR. Serotonin is responsible for mood stability as well as sleep mechanisms and digestive systems of an individual. However various environmental factors such as genre, race, ethnicity and society impact genetics. Correlation of these factors with other conventional entities caused due to presence in a shared environment can also affect gene structure[8]. These standard factors can be adaptable or non-adaptable to human body viz cigarette smoking, alcohol consumption, drug addiction, drug abuse can cause severe effect on gene structures which in turn can trigger disequilibrium of chemicals and pervasiveness to chronic stress is found. Thus working in a shared environment where there is non-adaptability to foreign condition can cause depression.

Polycystic Ovarian Syndrome causing Anxiety and Depression

Polycystic ovarian syndrome (PCOS) is a hormonal disorder that manifests during the reproductive years. Individuals diagnosed with Polycystic Ovary Syndrome (PCOS) may experience infrequent menstrual cycles. Alternatively, it is possible to experience prolonged intervals lasting several days. Excessive levels of androgen hormone may also be present in your body. Polycystic ovarian syndrome (PCOS) is characterized by the formation of several tiny fluid-filled sacs along the periphery of the ovary. These structures are commonly referred to as cysts. The cysts are characterized by their small size and fluid-filled nature, and they contain eggs that are in an immature state. These structures are commonly referred to as follicles. The follicles exhibit irregularity in the release of eggs. The precise etiology of polycystic ovary syndrome (PCOS) remains uncertain[9]. The implementation of timely identification and intervention, along with the achievement of weight reduction, has the potential to mitigate the likelihood of enduring problems, including type 2 diabetes and cardiovascular ailments.

Maternal Single Status ,Widowhood as well as Separation

Circumstantial changes occuring in life of a woman can cause separation, death of loved one or even loss of partner in old age. All these conditions can trigger depression owing to burden of varied responsibilities in these distinguished walks of life[10]. However, rendering a child by a single mother is challenging in its own way. Owing

to disparity, distress occurs which can be acute. Taking care of an infant right from birth, puberty, adulthood and giving a robust itself is a major concern which needs to be addressed by single mother[12]. Also loss of a loved one, leads to emptiness in life which can be seen in behaviour, routine, emotions affecting total health of an individual. Amidst all these, breakup, disturbed relationship, disputes in marriage can also severely affect mental health of women[11].

Post-traumatic Depression in Woman

Post-traumatic stress disorder (PTSD) is a psychiatric condition that arises as a result of exposure to a traumatic or unfavourable environmental experience, which has caused significant pain or injury. The structured interview is currently the predominant therapeutic method utilized for diagnosing post-traumatic stress disorder (PTSD)[13]. However, it is important to acknowledge that this approach is not without its drawbacks, one of which involves the stigma that is sometimes attached to individuals suffering from this condition.

Markers for Stress Detection

ECG(Electrocardiogram)

Heart Rate Variability (HRV) plays a crucial function in the identification of stress[14]. The RR/NN interval refers to the time duration between two consecutive heartbeats.The identification of variations in normal beat rates (RR interval) can be quantified through the application of statistical metrics such as standard deviation (SDNN), the average of all standard deviations of heartbeats (AVNN), the square root of the mean of squared differences of successive RR intervals (RMSSD), and pNN50 (the percentage of differences between successive RR intervals that are larger than 50s). All of these metrics fall within the category of time domain characteristics. HRV features such as NN, AVNN, SDNN, RMSSD achieved sensitivity score of 80% using Multilayer Perceptron Algorithm(MLP)[14]

EEG(Electroencephalography)

The ratio of low to high frequency can also be considered as a relevant statistic for EEG(Electroencephalography) [15].Hormonal imbalances resulting from chemical changes in the brain can lead to the emergence of undesired stimuli that impact the flight or fight response mediated by the sympathetic nervous system. The detection of curve anomalies can be accomplished through the utilization of Fractal dimension techniques such as Higuchi, Katz, and Permutation Entropy. These approaches are employed for the purpose of extracting features. By employing these techniques, it is possible to do dimensionality reduction, a process that aids in the regulation of brain activities. The EEG signal, derived from Electroencephalography, is considered an optimal non-invasive modality that poses no harm to the human body[16]. Using the Higuchi's Fractal Dimension technique, accuracy of 100% is achieved using Multilayer Perceptron (MLP) classifier. Also using Sample Entropy technique accuracy of 97.56% is achieved [17].

EDA (Electrodermal Activity)

The measurement of skin susceptibility can be conducted through the utilization of a photoplethysmogram (PPG) technique, which involves the implementation of a pulse oximeter to identify alterations in the blood volume beneath the skin tissue. The quantification of the oxygen absorption ratio in blood vessels inside skin tissue can be achieved through the utilization of light radiation. According to [18], application of GSR(Galvanic Skin Response) was done using EDR(electrodermal response) and results were obtained using different criteria like eating disorders, somatoform disorder, ADHD (Attention - Deficit Hyperactivity Disorder) , Obessive Compulsive Disorder. Evaluation was done using statistically proven t-test and significance was obtained with p-value < 0.01.

Role of Linguistics and Phonetics Aspects of Speech

The vitality of speech signal can be obtained through Trier Social Stress Test which includes delivery of speech on a particular topic, for perusal of job in a company. On the basis of audio information, detection of depression is done using physiological markers like heart beat, respiratory rate and steroid based cortisol hormone which is released by adrenal glands on top of kidneys[19][20]. As per the research work proposed in [21], approach used was Bi-LSTM (bidirectional Long-Short Term Memory) with an implementation of multimodality. Data was collected over 59

interviews which involved 29 depressed patients and 30 control participants. Accuracy of 80% was achieved which also showed that multimodal approaches outperformed unimodal behaviour of datasets.

Questionnaires and Tests
Beck Depression Inventory
It is a crucial instrument within the realm of mental health, facilitating the comprehension and evaluation of depression symptoms in individuals by specialists. Nevertheless, it is vital to utilize it in conjunction with a thorough clinical evaluation to guarantee a more precise diagnosis and formulation of a treatment strategy. Beck Depression Inventory (BDI) comprises of Numerical and Statistical Methodologies. Various methods are used to monitor mood swings, irritations, negative thought processes and physical complexities using a 0-3 point scoring system. Labels are generated by summing up the scores which can be bifurcated into mild, moderate and severe levels of depression. An attempt is made to provide comparisons based on different frameworks like CNNs, RNNs. Testing was done on AVEC 2013 and AVEC 2014 datasets. The discussed method is quite remarkable and promising results can be obtained for future diagnosis [22].

Patient Health Questionnaire (PHQ-9)
There is use of scale ranging from 0-3 for detection of stress primarily, more recurrently occurring not less than 2 weeks. With a more comprehensive outlook a follow up containing 27 questions is also surveyed for precision in diagnosis. This classification is based on point system where categories of mood swings range from minimal, mild, moderate and severe. With PHQ-9 (score >9) (no of patients=1076) were diagnosed. Out of which 23.1% were susceptible to diagnosis by doctor. With (score >=15), 30.8% were diagnosed with depression and with (score>=20), 49.4% were found to be depressed [23].

Hamilton Rating Scale for Depression (HAM-D)
The primary method employed by the Hamilton Rating Scale for Depression involves conducting a structured clinical interview with the individual. This interview is typically administered by a healthcare professional who possesses specialized training, such as a psychiatrist or psychologist. During the interview, the professional assesses the patient's behavioural patterns, emotional state, and physical manifestations of symptoms experienced within the preceding week. The healthcare professional assigns a numerical value to each item, taking into account the patient's replies and their own observations. The severity of depression is deemed to be greater as the overall score increases. The scale is widely available and has two common versions with either 17 or 21 items and is scored between 0 and 4 points. Scoring is based on the 17-item scale and scores of 0-7 are considered as being normal, 8-16 suggest mild depression, 17-23 moderate depression and score over 24 are indicative of severe depression [24].

Stroop Color Word Test
It is a clinically proven psychological test used to detect anxiety. It is an illusionary test where words are written in various colors like red, green and blue. The Stroop effect is a well-documented psychological phenomena that provides empirical evidence of interference in reaction time during a cognitive task. The phenomenon under consideration arises when the written representation of a color is presented in a hue that does not correspond to the semantic meaning of the color term viz red, green and blue, hence impeding participants' ability to promptly and properly identify the actual color being depicted[25].

VIML and Attention based AI Techniques for Regulating Mental Health in Woman

Wholesome Approach for Model Building:Machine Learning
It is possible to utilize diverse data sources in order to identify and detect instances of depression[26]. The sources encompass a variety of data types, such as text data derived from social media posts, electronic health records, audio recordings, and other relevant sources. In the context of text data analysis, potential methodologies encompass sentiment analysis, keyword identification, and linguistic pattern recognition. In the context of audio data, characteristics commonly encompass pitch, tone, and speech pace[27].Numerous systems for detecting depression

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employ supervised learning methodologies. This process entails training the model using a labeled dataset in which individuals are categorized as either experiencing depression or not experiencing depression. According to [28], obtained results show that variance and standard deviation coupled with SVM classifier based on supervised Machine Learning technique achieved AUC(area under the curve) of 0.97.

Natural Language Processing

The application of natural language processing techniques is prevalent in the analysis of textual material for the purpose of detecting depression. Natural Language Processing (NLP) algorithms have the capability to examine the textual content found in many sources such as social media posts, online forums, and clinical notes[29]. By doing so, these algorithms can identify language clues and sentiment patterns that are indicative of depression. Sentiment analysis, topic modeling, and word embeddings are among the natural language processing (NLP) approaches employed in the field. The transformer-based approach for Natural Language Processing (NLP), achieved precision, recall and F1-score of 0.82, 0.81 and 0.82 respectively[29].

A Multifaceted Convolutional Neural Network Based Approach

According to [30] utilization of an attention-based Convolutional neural network (CNN) and long short-term memory (LSTM) technique is ensemble to integrate non-invasive data, including eye data, vehicle data, and environmental data obtained from sensors. There is autonomous extraction of information from individual modalities and varying levels of features are merged from distinct modalities using a self-attention function, to obtain specificity[31]. The study offers an automated methodology for gathering and assessing tweets using self-reported comments. Additionally, a multimodal framework has been proposed to predict symptoms of sadness based on user profiles. Findings include n-gram language models, LIWC dictionaries, automatic picture tagging, and bag-of-visual-words techniques to obtain relevant feature set according to[32].The correlation-based feature selection strategy in combination with nine distinct Machine Learning classifiers exhibit efficacy to generate class labels pertaining to depressive or non depressive symptoms [33]. Additionally, a Multimodal Hierarchical Attention (MHA) model is introduced for the purpose of detecting depression in social media content. The model receives multimodal data and applies the attention mechanism simultaneously within and across modalities. After applying distribution normalization, the MHA model can achieve accuracy and F1-score of 92.84% and 92.78% respectively[34].

Machine Learning and Wearable Sensors

In this study, a range of Machine Learning models have been utilized for the identification of stress in individuals. These models are applied to a publically accessible multimodal dataset known as WESAD[35][36]. The collection of sensor data, such as electrocardiogram (ECG)[14], body temperature (TEMP), respiration (RESP), electromyogram (EMG)[16], and electrodermal activity (EDA)[18], is conducted for the purpose of studying three distinct physiological states: neutral (baseline), stress, and amusement[37]. The F1-score and accuracy metrics were calculated for both three-class (amusement vs. baseline vs. stress) and binary (stress vs. non-stress) classifications[38][39]. These classifications were performed using various machine learning approaches, including k-NN, Linear Discriminant Analysis, Random Forest, AdaBoost, and Support Vector Machine. For both binary and three fold classification, Random Forest achieved F1 score of 83.34% and 65.73%[35].

Hybrid Deep Learning Model Based on social media

According to [31], user posts have been enhanced with supplementary attributes derived from Twitter. There is employment of a two-tier attention mechanism to encode user posts. This mechanism operates at both the tweet-level and word-level, allowing determination of relevance of each tweet and individual words. By doing so, extraction of semantic sequence patterns from the user timelines was available, thereby enhancing detailed understanding of posts. The hierarchical attention model was capable to effectively catch patterns, hence enabling the generation of explainable outcomes. The proposed model is a fusion of two deep learning architectures, Convolutional Neural Network(CNN) and bi-directional Long Short-Term Memory (biLSTM) which provides

optimized result upto 94.28%. Relevance of literature work Is obtained, out of which comparisonshave been annotated as shown in table I

CONCLUSION

The proficient utilization of technology in the treatment of mental illness among women holds the capacity to fundamentally transform our approach to mental healthcare. In addition to this, the utilization of machine learning and artificial intelligence enables the analysis of extensive datasets, facilitating the prediction of prospective mental health issues. This, in turn, facilitates the implementation of timely interventions and preventive measures. Throughout the course of this discourse, there is enhancement of mental health treatments for the mitigation of societal stigmatization. In addition, the advancement of technology has facilitated the creation of evidence-based therapies and assessment instruments in form of questionnaires and tests that may be tailored to address the unique requirements of women with mental health challenges.

Future Work
Pertaining to the written discussions above, it can be seen that the corpus collected is based on realistic data which depicts the emotions and sentiments of depressed patients on an instance or over a period of time. Owing to the applicability of sensing devices variance is obtained in detection of physiological signals which may affect accuracy and precision in detection of class labels, whether depressed or not depressed. In addition to the above, future work will provide a seamless approach which will provide accurate and promising results for depression detection among female patients by developing a collaborative methodology based on Artificial Intelligence and Machine Learning that supports multimodal behaviour of dataset, as well as extracting relevant features from human naturalistic data using sensor based techniques.

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Table 1. Comparisons have been annotated based other survey papers

Author, Year	Area of Focus	Techniques introduced in survey	Outcome of Survey
Aleem *et.al.*(2022)[40]	Diagnosis of MDD, anxiety, bipolar disorder, migraine, stress, schizoprenia	Use of various machine learning algorithms like naïve bayes, support vector machine, random forest , Decision Tree	Efficacy of various Machine Learning algorithms was rationalized and it was found that SVM classifiers developed an accuracy of 75%
Joshi *et.al.*(2022)[41]	Detection of depression from emotional behaviour using facial expressions, images, emotional chat bots and texts on social media platforms.	Use of various Artificial Intelligence and Machine Learning techniques like ANN(Artificial Neural Network), Naïve Bayes, Logistic Regression, Support Vector Machine respectively	According to analysis of work done, SVM performs better but for more precise results in future, for precision, recall and F-measure, decision tree performs better.
Habtamu *et.al.*(2023)[42]	Preferred Reporting Items for Systematic Reviews and Meta Analysis(PRISMA) was implemented.	A data extraction form was prepared based on studies like population, sample size, gender, age.	Out of 23,305 records collected using varied types of questionnaires, more relevance of results was obtained from educational background
Fekadu *et.al.* (2022)[43]	Attempt is made to generalize survey of depression diagnosis in low and middle income countries	Diagnosis was done based on 9 item PHQ-9 with a cut off score of 5 and 10. Analysis was done on datasets like PubMed, PsycINFO, MEDLINE.	Survey indicated that extremely detection of depression was not upto the mark for diagnosis in low and middle income countries.
Babu *et. al.*(2022)[44]	Attempt is made to perform sentiment analysis of individuals based on social media data	Social media data containing text, emoticons and emojis were utilized for identification using Artificial Intelligence techniques.	It was found that multi class classification with Deep Learning algorithm showed higher precision value during analysis

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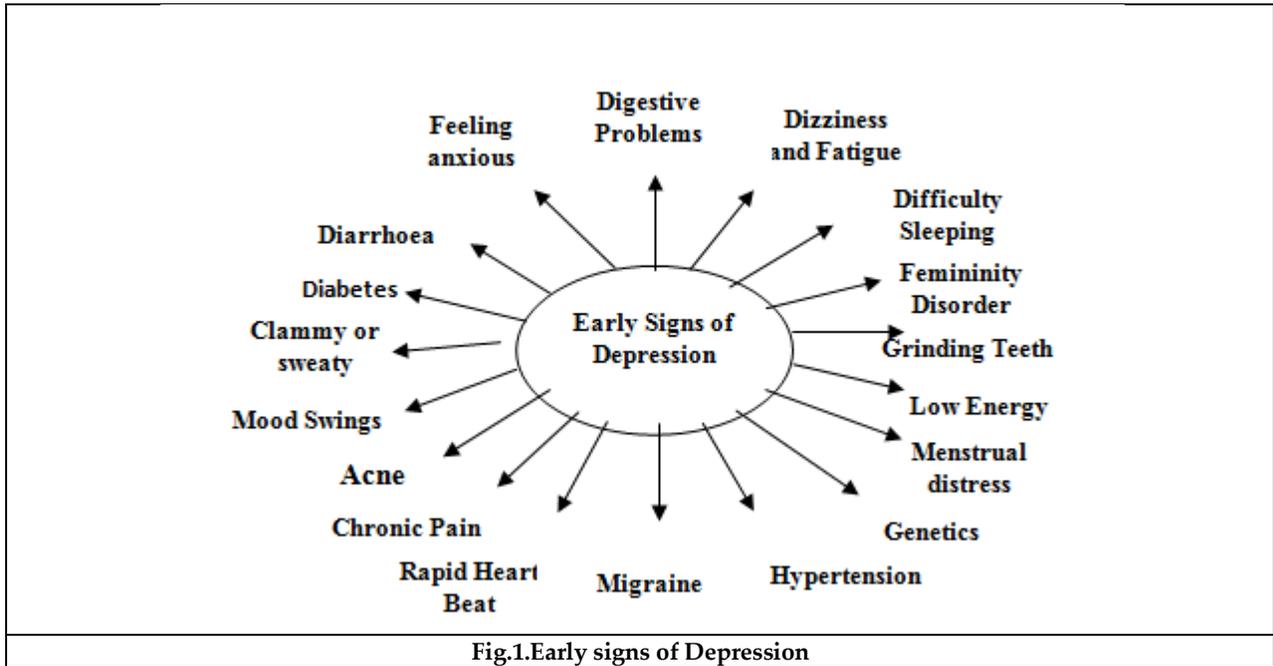
Fig.1.Early signs of Depression

RESEARCH ARTICLE

Consumer Buying Behavior and Ubiquitous Expostulate and Perplexity in Buying Organic Products

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ABSTRACT

The term "green purchasing behavior" describes the practise of buying goods that are kind to Mother Earth, easy to recycle or reuse, and considerate of environmental safeguards. A sampling technique is a method for selecting a subset of a population to serve as a representative sample for the whole. For the purpose of selecting organic consumers, the researcher employed convenience sampling. Research samples should be large enough to be statistically valid representations of the target population. The connection between product choices, environmental sustainability, and individual health is becoming more apparent in today's consumer landscape. Organic product sales and health consciousness are positively impacted by consumer education and environmental consciousness. As consumers learn more about the effects of their food choices on ecosystems and human health, they are increasingly looking for organic options. Notably, factors such as perceived cost, organic product certification, and labelling do not seem to significantly influence customer purchasing decisions.

Keywords: Environmental Sustainability, Green Purchase Behaviour, Organic consumers, Organic Products, Purchase Intention.

INTRODUCTION

Environmental and health concerns are rising in the minds of today's consumers. People are starting to shift their buying habits and are increasingly seeking for organic products, which are made with minimal environmental impact. Sustainable, created with natural resources, packaged simply, and free of pesticides are the hallmarks of

organic products. To sum up, organic consumers are people that think about the environmental impact of what they buy and how they throw it away, as well as the products themselves, before making a purchase.

LITERATURE REVIEW

The term "green purchasing behaviour" was coined by Mostafa (2007) to describe consumers who actively seek out and buy eco-friendly goods that are also easy to recycle or preserve. The trend toward "becoming green" is indicative of a societal concern for the future of Earth's natural resources, which Clem (2008) argues must be safeguarded for the benefit of humankind. The need for eco-friendly goods has grown as people's consciousness about environmental problems has grown. Green goods sales are positively correlated with customer attitudes toward environmental protection. Consumers' opinions and purchasing intentions may also shift in response to the ongoing environmental crisis. In marketing literature, the idea of consumer purchasing intention has been significant. Consequently, a customer's likelihood of making a decision to acquire environmentally friendly products is positively impacted by purchasing intention. The desire to buy environmentally friendly products is heavily influenced by consumers' concerns about the environment. Therefore, people buy eco-friendly products for reasons other than environmental concerns. Other things also contribute to the buying. When compared to conventional products, consumers are less likely to buy environmentally friendly options if they are more expensive and of worse quality.

According to what Denise Rennie and Farah Ayuni Shafiea have said If we want to know if the organic industry can sustain its rapid expansion and become a true mainstream market, we need to know what drives people to buy organic food, what they believe in, and how their demographics affect their purchasing decisions. Human health, food safety, environmental concerns, and sensory qualities including nutritional content, flavour, freshness, and beauty are just a few of the reasons why there have been numerous studies comparing organic versus conventional food. Everyone has their own opinion when it comes to organic food. Dantasetal. (2004) states that there are a mere few seconds for a product's label and packaging to make an impression on a buyer. In that little window, the product must captivate the eye and persuade the purchaser that it is the best choice available (Rowan, 2000). The following characteristics were selected for this study as influencing customers' purchasing behaviours for environmentally friendly items based on the literature review.

Objective of the Study
1. To explore the influence of Health consciousness and its impact on consumer buying intentions towards organic products.
2. To investigate the impact of consumer environment concern on consumer behavior towards purchase of organic products.

RESEARCH METHODOLOGY

A Quantitative study on consumers to explore the buying intentions of organic products was conducted. The researcher has collected data from 142 consumers of Bengaluru City through a structured questionnaire.

Population of Organic Consumers in Bengaluru
Organic Consumer's Average footfall in Organic Retailer's Stores in Bengaluru Districts.

Taluk	Population of Organic Consumers
Bengaluru South Taluk	36
Bengaluru East Taluk	37
Bengaluru North Taluk	42
Bengaluru North(Additional) Taluk	27
Total	**142**

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Sampling Method

The sampling technique infers to the process by which a representative sample is selected from the population. The researcher used convenience sampling for selecting the organic consumers. The sample size selected for study must be appropriate to represent the population of the study.

HYPOTHESES OF THE STUDY

Ha1: Consumer awareness will have a positive impact on consumer's purchase intentions towards organic product.

Ha2: Environmental concern will have a positive impact on consumer's purchase intentions towards organic product.

Ha3: Health consciousness will have a positive impact on consumer's purchase intentions towards organic product.

Ha4: Perceived expensiveness will have a impact on consumer's purchase intentions towards organic product.

Ha5: Labelling and certification on organic products, have a positive impact on consumer's purchase intentions towards organic product.

Data Analysis and Interpretation

Exploratory Factor Analysis results

Communalities

	Initial	Extraction
aw_1	1.000	.878
aw_2	1.000	.904
aw_3	1.000	.904
aw_4	1.000	.914
aw_5	1.000	.904
aw_6	1.000	.872
En_1	1.000	.851
En_2	1.000	.903
En_3	1.000	.923
En_4	1.000	.935
En_5	1.000	.905
he_1	1.000	.925
he_2	1.000	.906
he_3	1.000	.918
he_4	1.000	.937
pc_1	1.000	.941
pc_2	1.000	.948
pc_3	1.000	.931
wi_1	1.000	.735
wi_2	1.000	.856
wi_3	1.000	.853
wi_4	1.000	.869
wi_5	1.000	.848
wi_6	1.000	.791
wi_7	1.000	.848
ocampol_1	1.000	.902
ocampol_2	1.000	.936
ocampol_3	1.000	.909

Extraction Method: Principal Component Analysis.

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.933
Bartlett's Test of Sphericity	Approx. Chi-Square	5654.353
	Df	378
	Sig.	.000

Data Validation and Reliability test

The fundamental ideas that defy reduction to a single measurable variable are represented by factors. The method of maximum likelihood with promax rotation was used. We checked if the things could be factored. We used the Kaiser-Meyer-Olkin measure and Bartlett's test of sphericity to determine if our samples were large enough. Both the KMO test value (.933) and Bartlett's test of sphericity (significant) were determined to be more than the suggested value of 0.6. Eigen values were used to extract six elements. We only kept the components whose Eigen values were greater than 1.

Total Variance Explained									
Compon ent	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulativ e %	Total	% of Variance	Cumulativ e %	Total	% of Variance	Cumulativ e %
1	16.416	58.629	58.629	16.416	58.629	58.629	5.824	20.801	20.801
2	2.370	8.465	67.094	2.370	8.465	67.094	5.211	18.612	39.413
3	2.081	7.431	74.525	2.081	7.431	74.525	4.661	16.648	56.061
4	1.789	6.388	80.913	1.789	6.388	80.913	3.794	13.550	69.611
5	1.367	4.883	85.796	1.367	4.883	85.796	2.972	10.613	80.224
6	.924	3.299	89.095	.924	3.299	89.095	2.484	8.871	89.095
7	.514	1.837	90.932						
8	.331	1.182	92.115						
9	.251	.898	93.013						
10	.209	.747	93.760						
11	.187	.667	94.427						
12	.172	.614	95.041						
13	.150	.537	95.578						
14	.139	.495	96.073						
15	.134	.477	96.550						
16	.124	.444	96.995						
17	.109	.390	97.384						
18	.100	.357	97.742						
19	.096	.343	98.085						
20	.090	.321	98.405						
21	.081	.288	98.693						
22	.067	.240	98.933						
23	.065	.231	99.164						
24	.058	.209	99.373						
25	.055	.195	99.567						
26	.049	.174	99.741						
27	.038	.136	99.877						
28	.034	.123	100.000						
Extraction Method: Principal Component Analysis.									

Rotated Component Matrixᵃ

	1	2	3	4	5	6
				Component		
aw_1My level of awareness about Organic Product is extremely good.		.820				
aw_2My level of awareness about Health benefits of Organic product is extremely good		.839				
aw_3My level of awareness about Environmental benefits of Organic product is extremely good		.786				
aw_4My level of awareness about point of Purchase/availability of Organic Product is extremely good		.802				
aw_5My level of awareness about various Brands offers Organic product is extremely good		.790				
aw_6My level of awareness about various Certification of Organic product is extremely good		.791				
En_1Environmental pollution is a serious issue			.813			
En_2I am greatly concerned about the harm being done to plant and animal life by pollution			.853			
En_3The government should pay more attention to environmental issues			.842			
En_4I feel I am more environmentally conscious than most people			.862			
En_5Organic food is more environmentally friendly			.807			
he_1Organic products are more nutritional than conventional food				.837		
he_2Organic products are healthier than conventionally grown food				.844		
he_3Organic products are more safety to consume and contain less health risk				.825		
he_4Organic food tastes better				.822		
pc_1Only consumers with higher income can afford organic food					.867	
pc_2Organic food is too expensive					.879	
pc_3Organic food is beyond my budget					.815	
wi_1I will continue to consume organic products without affect by the price changes	.708					
wi_2I am willing to pay a higher price for organic products	.783					
wi_3I don't mind spending more time sourcing for organic food	.810					
wi_4Buying organic food is the right thing to do even if they cost more	.803					
wi_5I'm willing to buy organic food even though choices are limited	.799					
wi_6I would still buy organic food even though conventional alternatives are in sale	.813					
wi_7I'm willing to buy organic food because the benefits outweigh the cost	.818					
ocampol_1I will only purchase organic products with organic certification or organic labeling						.748
ocampol_2Organic labeling and certification is important for me to recognize organic products						.809
ocampol_3Organic label is affecting my willingness to pay for organic products						.735

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
a. Rotation converged in 6 iterations.

Measurement of Goodness-of-fit-Statistics

Goodness-of-fit-statistics	Score	Recommended Levels
Degrees of freedom	335 (406 - 71)	As low as possible
Minimum fit Function Chi-square	715.071	As low as possible
CMIN/DF	2.135	< 5
Chi-Square significance	0.000*	P<0.05
Root Mean square error or approximation (RMSEA)	.090	.08
P-Value for test of close Fit	0.000	(RMSEA <0.05)
Normed Fit Index (NFI)	0.883*	>.95

Comparative Fit Index (CFI)	0.934**	> .90
Goodness of Fit Index (GFI)	0.727*	>.90
Adjusted Goodness of Fit Index (AGFI)	0.699	Higher the better

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
a. Rotation converged in 6 iterations.

There are six components that make up consumer awareness as a whole. These include: an exceptionally high degree of knowledge regarding organic products; an equally high degree of knowledge regarding the health and environmental benefits of organic products; an exceptionally high degree of knowledge regarding the availability and point of purchase of organic products; and an exceptionally high level of knowledge regarding the various brands' offerings. Loadings of 0.820, 0.839, 0.786, 0.802, 0.790, and 0.791 indicate that consumers have a high level of knowledge regarding organic products and certifications. The first component, "Consumer awareness," explained 20.801% of the total variation. The second component, "Environmental Attitude," which consists of five items, explained 18.612 percent of the total variation. I am really worried about the damage that pollution is doing to plant and animal life, and I think that environmental pollution is a major problem. I like to think I'm more eco-aware than the average person, but I still think the government should do more to protect the environment. A lower carbon footprint is associated with organic food (loadings of 0.813, 0.853, 0.842, 0.862, and 0.807, respectively). Items with loadings of 0.837, 0.844, 0.825, and 0.822 from the third factor include: the nutritional value of organic food is higher than that of conventionally grown food; the health benefits of organic food outweigh the risks to human health; the safety of consuming organic food; and the fact that organic food tastes better. "Health Consciousness" was the factor's name, and it explained 16.648 percent of the variation. The fourth component includes item loadings Factor loadings for organic food were 0.867, 0.879, and 0.815, respectively, suggesting that only customers with higher incomes could purchase it. A total of 13,550 percent of the variance was explained by the "Perceived Expensiveness" component. The fifth factor includes seven items that have loadings. These include: I will continue to buy organic products regardless of price changes, I am willing to pay more for them, I don't mind spending more time looking for organic food, I think it's right to buy organic food regardless of price, I would still buy organic food even if my options are limited, I would buy organic food even if conventional alternatives were on sale, and finally, I think the benefits of buying organic food are worth the price. has collectively explained 10.613% of the variation, with loadings of 0.708, 0.799, 0.813, and 0.818. The "Willingness to Pay" metric represents this component. The sixth factor includes three items with loading values of 0.748, 0.809, and 0.735, respectively, regarding factors such as "I will only purchase organic products with organic certification or organic labelling," "Organic label is affecting my willingness to pay for organic products," and the importance of organic certification and labelling for recognising organic products. An element known as "Labelling and Certification" describes it.

Confirmatory Factor Analysis
Six latent constructs—Consumer Awareness, Environmental Concern, Health Consciousness, Perceived Expensiveness, Willingness to Buy Organic Products, Labeling, and Certification—and their corresponding manifest variables were subjected to Confirmatory Factor Analysis (CFA) in order to assess the measurement model's uni-dimensionality. To confirm the association between the latent and manifest variables, Hair et al. (2006) proposed using Goodness of Fit (GOF) indices, namely absolute fit indices, parsimonious fit indices, and incremental fit indices.

According to the measurement model fit indices table, the cut off value is 2.135, which is lower than what is considered acceptable. It is necessary to employ numerous measures concurrently in order to determine the appropriate model from the acquired data (Hooper, et al., 2008). Therefore, there are additional goodness-of-fit indices that are considered. The calculated CFI value of 0.934 is more than the minimal cutoff value of 0.9. (Arbuckle, 2010). Seems like RMSEA = 0.090 is higher than the cutoff of 0.08.

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Findings of the Study
Outcomes of Hypothesis

Hypothesis Relationship	Standardized Estimates	t-value	p-value	Decision
WIL<---AW	0.324	4.289	***	Supported
WIL<---EN	0.133	2.002	0.045	Supported
WIL<---HE	0.275	2.566	0.347	Not Supported
WIL<---PC	0.068	0.940	0.102	Not Supported
WIL<---OCAMPOL	0.124	4.192	0.112	Not Supported

Ha1: Consumer awareness will have a positive impact on consumer's purchase intentions towards organic product – Supported
Ha2: Environmental concern will have a positive impact on consumer's purchase intentions towards organic product – Supported
Ha3: Health consciousness will have a positive impact on consumer's purchase intentions towards organic product – Not supported.
Ha4: Perceived expensiveness will have a impact on consumer's purchase intentions towards organic product – Not supported.
Ha5: Labelling and certification on organic products, have a positive impact on consumer's purchase intentions towards organic product – Not Supported

Suggestion

The goal of educational campaigns like Campaigns for Awareness and Education is to get the word out about the health benefits of organic products. Bring awareness to the fact that eating organic food has long-term, nutritional, and scientific advantages. Promote the environmental advantages of purchasing organic products, including less pesticide use, better soil, and more biodiversity. Affordable Rates work toward bringing the price of organic goods down to a level where they are competitive. Consider ways to reduce marketing, distribution, and production costs so you can pass the savings on to your customers. Loyalty programmes, rebates, and promotions are all viable incentives that could boost the economic attractiveness of organic options. Offering a diverse range of organic products allows you to cater to your consumers' diverse wants and tastes. Make it easy for consumers to personalise their purchases or offer affordable trial packages of several products. Working Cooperate with Influencers team up with influential people whose beliefs align with your company's. With their large followings and honest reviews, influencers can boost the trustworthiness of your organic products. Comments and Acceptances regularly solicit input from customers to gain insight into their expectations, concerns, and preferences. Always be ready to adjust your strategy based on what your customers tell you and how the market is changing.

CONCLUSION

There is a growing awareness in today's consumer culture of the interconnectedness of product choices, ecological sustainability, and individual well-being. Organic product sales and health consciousness are positively impacted by consumer education and environmental conscience. A growing number of consumers are considering the effects of their purchasing habits on future generations' health and the planet, driving up demand for organic goods. Fascinatingly, factors including perceived cost, organic product certification, and labelling don't seem to be nearly as influential on customers' purchasing decisions. This shows that consumers are shifting their focus from price and confusing product labels to the more basic advantages of being environmentally conscious and healthy. Customers seem to put more stock in the obvious benefits of organic products, viewing them as a way to show their support for sustainable practises while also investing in their health. Understanding the nuanced factors that influence customer choices is crucial for businesses and sectors as they adapt to the new normal. Businesses could stand a greater chance

of attracting and retaining customers if their marketing campaigns highlighted the organic products' inherent health and environmental benefits rather than the items' perceived price or complicated certifications. Modern consumers are more aware than ever before of the ways in which their purchasing habits can have far-reaching effects on ecosystems and communities. In order to cater to the evolving tastes of a more knowledgeable and conscientious market, it is crucial to prioritise openness, sustainability, and consumer education in light of this new reality.

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| Fig 1:Exploratory Factor Analysis | Fig 2:Confirmatory Factor Analysis |

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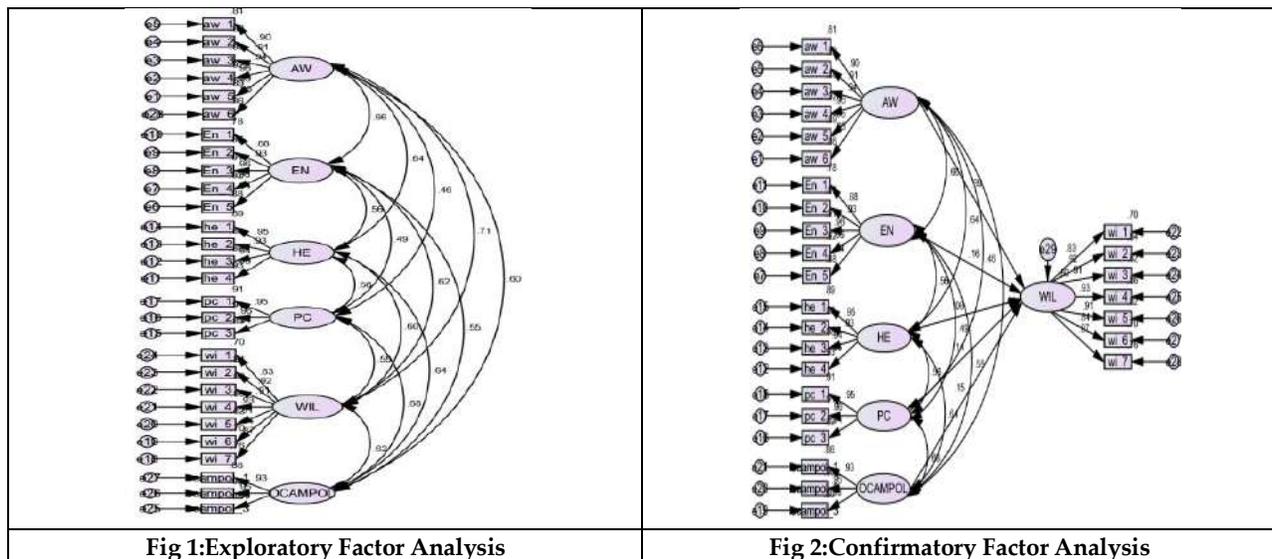
Relationship between Isometric Trunk Muscle Strength, Balance, and forward Reaching Ability in Children with Cerebral Palsy

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ABSTRACT

Trunk muscle strength is impaired in children with cerebral palsy thus influencing their functional balance. Forward reaching is an important test and an essential component of daily life activities. However, there is paucity of literature determining the relationship between trunk muscle strength, balance and forward reaching ability in children with CP. The study intends to assess relationship between trunk muscle strength, balance and forward reaching ability in children with cerebral palsy from Surat city. This cross-sectional observation study included 47 children with cerebral palsy from physiotherapy and rehabilitation setups of Surat. Children with CP were assessed using stabilizer pressure biofeedback equipment and trunk control muscle scale for muscle strength; pediatric balance scale for balance and forward reach test for reaching ability after signing informed consent from their parents. The data was analysed using Microsoft Excel and SPSS 20.0.The findings are suggestive that there is moderately strong correlation between the isometric trunk muscle strength and balance; the isometric trunk muscle strength and forward reaching ability or balance and forward reaching ability. The study implicates use of trunk control and strength measures in rehabilitation of CP children to improve balance and functional independence.

Keywords: Balance, cerebral palsy, functional reach, physiotherapy, trunk muscle strength.

INTRODUCTION

Cerebral palsy [CP] is one of the commonest causes of motor disability in children with some amount of dysfunction of posture and movement [1]. Because ability to control posture is an integral part of all movements, deficits in the postural control system contribute to the challenges in body structure and function, daily activities, and participation of children with CP [2]. Balance dysfunction associated with impairment in trunk control is usually reported in children with CP who have lower levels in Gross Motor Function Classification System [GMFCS], suggesting probable relationship between trunk control and balance with functional abilities in these children [3].Children at GMFCS levels IV–V have undeveloped postural control and require contextual modifications to enable opportunities for basic acquisition and practice of head and trunk control [4]. Trunk muscle strength is an important factor influencing the balance in normal individuals as well as in children with CP [5]. The purpose of this study was to find relationship between the isometric trunk muscle strength, balance and forward reaching ability among CP child.

MATERIALS AND METHODS

- **Study Setting** The Study was conducted at various hospital, neuro-rehabilitation centers, and physiotherapy departments in Surat city of Gujarat.
- **Sample Population** Children with CP attending in neuro-rehabilitation centers, hospital, and physiotherapy department in Surat.

Inclusion Criteria
Children with CP from both genders were included if they fit following criteria-
1. Age of 5 to 15 years of age.
2. GMFCS level I, II and III.
3. Children able to understand the test instruction, able to sit and stand.
4. Parents of child who willingly consents for their child's participation in the study.

Exclusion Criteria
Children with CP were excluded if they fit following criteria
1. Parents of child not willing for their child's participation in the study
2. Children who prescribe with the botulinum toxin in the last six month or intrathecal baclofen pump implantation.
3. Child who has a history of injury to spine and pelvis, on medication like antiepileptic and anti spastic drugs.
4. Children who have progressive neurological disorder, genetic or metabolic disorder and severe concurrent and illness or diseases not typically associated with CP or other than CP. [e.g., traumatic brain injury or acute pneumonia].

Procedure
Data was collected from various hospital, neuro rehabilitation centers and physiotherapy departments of Surat. Parents were invited and explained about the study. After that parents who were willing to participate were asked to sign all informed consent form. Children with CP were screened and selected, based on inclusion and exclusion criteria through convenience sampling .Children were assessed for isometric trunk muscle strength using core stabilizer [6];forward reaching ability by Functional Reach Test [FRT] [7]; and balance by Pediatric Balance Scale [PBS][8]. Results were analysed using SPSS 20.0 and Microsoft Excel for Windows.

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RESULTS

The demographic data were analysed using frequency distributions. Correlations between the outcomes were evaluated using Pearson's correlation co-efficient as comparison of baseline data showed normal distribution using Kolmogorov–Smirnov test. Demographic distribution of the subjects in the study sample is shown in table-1. Mean age of the children included in the study was 9.17± 2.58 years and most of the children [n=31] were from 5-10 years' age group. It is also evident that most of the children included were diagnosed as diplegic [n=21] or hemiplegic [n=21] type of CP. Table-2 shows the correlation co-efficient values for average core muscle strength [mm Hg], pediatric balance scale score, and average functional reach distance [cm]. Values of correlation coefficients for all the variables considered, showed positive correlation with each other as the values are all greater than 0 [9]. The findings are suggestive that there is moderately strong correlation between the isometric trunk muscle strength and balance; the isometric trunk muscle strength and forward reaching ability; and balance and forward reaching ability.

DISCUSSION

As the studies from Gujarat including CP children and correlating trunk muscle strength and balance in them are not available, the discussion will present unique findings with probable justifications keeping in mind the objectives of the study. Demographics of the participants from the present study are in concurrence with other studies showing that most of the children with CP were primarily diagnosed as diplegic or hemiplegic type of CP [11,12]. Present study shows moderately strong positive correlation between the isometric trunk muscle strength and PBS scores as well as FR distance; which is supported by previous studies [13,14].Monica *et. al*. [2021]; Lim, Lee, and Lim [2021]; and Kim, An and Yoo [2018] have concluded that trunk control and trunk muscle strength are important factors affecting the balance activities including functional reach activities [3,12,15].

Static, active, and reactive postural control involves complex neural processes coupled with biomechanical and environmental constraints. As postural control during all the movements is integral to daily life activities, deficits in the posture system can contribute to the challenges in body structure and function, daily activities, and participation [4,16]. In addition, impaired trunk control in children with spastic CP is associated with balance dysfunction [3].It has been documented that, children with CP at GMFCS levels IV–V have under-developed postural control and therefore require contextual modifications to enable opportunities for acquisition and practice of head and trunk control [16].The reason for the moderately strong correlation found in this study can be attributed to the fact that all the participants belonged to GMFCS levels I, II and III and were all able to sit and stand. The findings in this study indicate that the correlation between the balance and forward reaching ability is moderately strong. Postural trunk control during frontal plane movements is suggested to be more difficult than while performing trunk movements in the sagittal plane [13]. Based on the motor involvement, children in the lower GMFCS level have profound impairment of trunk control affecting forward reaching abilities of child and suggesting that there is relationship between functional abilities and trunk control.

Limitations and Further Recommendations

The sample size covered for the study was smaller when we consider the strength of population of children with CP in India. As only smaller geographical region of Surat city was studies, the sample shall be representative and future study can include more subjects stratified based upon the type, geography, age, and gross motor function levels. It is also recommended to use more stringent outcome to assess trunk muscle strength such as EMG to quantify the strength and make study robust.

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Table 1: Demographic Details of the Sample Population

Characteristic	Category	Frequency [n]
Age Group [years]	5 to 10	31
	11 to 15	16
Type of CP	Diplegic CP	21
	Hemiplegic CP	18
	Quadriplegic CP	6
	Monoplegic CP	2
Note: CP- Cerebral Palsy		

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Table 2: Pearson's Correlation between the Outcome measures

	Isometric Muscle Strength [mm Hg]	PBS Score	FR Distance [cm]
Isometric Muscle Strength [mm Hg]	1.000[3]	0.489[2]	0.457[2]
PBS Score	0.489[2]	1.000[3]	0.566[2]
FR Distance [cm]	0.457[2]	0.566[2]	1.000[3]
Note: • PBS- Pediatric Balance Scale; FR: Functional reach • 1- Weak correlation; 2- Moderate correlation; 3- Strong correlation [9]			

RESEARCH ARTICLE

Yield and Biochemical Profiling of Onion (*Allium cepa* L.) Under Different Growing Conditions

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ABSTRACT

Allium cepa L. of family Liliaceae is a wide-reaching therapeutic spice known as onion. Onions are extensive used in different cuisines around the world. This research establishes relative use of manure (M), Vermicompost (VC), Urea (UR), Muriate of potash (MOP), Single Superphosphate (SSP), Copper Sulphate ($CuSO_4$) and Mercuric chloride ($HgCl_2$) under different stress conditions to assess the yield and biochemical activity of their leaves. The range of biochemical parameters was recorded as Carbohydrate0.348±0.160 mg/ml (MOP)to0.170±0.136mg/ml (50mM $CuSO_4$); Protein0.069 ±0.0115 mg/ml (VC) to 0.0080±0.0040mg/ml (M), Free fatty acid 0.85±0.0288mg/ml (SSP)to0.3±0.0577mg/ml (10mM $HgCl_2$), fiber content1.82±0.008g (VC) to 0.91±0.061g (50mM $CuSO_4$), Ash content3.62±0.009g (20mM$HgCl_2$)to 1.81±0.005g (control soil) respectively. The highest scavenging activity of 82.46% in vermin compost by DPPH and minimum by Total Antioxidant Capacity of 10.17±0.829 (10mM $HgCl_2$) was recorded. Highest and lowest ascorbic acid value was recorded as3.89mg/100g (M) and 1.18mg/100g (10mM$HgCl_2$). For enzymatic antioxidant assay maximum value of 1.2±0.03 was recorded for Ascorbate oxidase in normal soil and minimum 0.001 ±0.05 (10mM $HgCl_2$) for catalase. The supplementary data acquired on yield and biochemical activity under different stress will contributes resource for

agricultural implementation and future references. The best combination of growth regulators can increase the productivity and yield of onion.

Keywords: Onion, Stress, Nutritional, Antioxidant, DPPH, catalase.

INTRODUCTION

Onion is the main part of human diet in different forms. It is commonly considered as the source of various medicinal properties in normal day to day life. Asaduzzaman et al., 2012 reported that Onion belongs to the family Amaryllidaceae or Liliaceae which is a cross pollinated crop. The growth and productivity of onion is the important concern as it can be affected by various environmental conditions. Vermi compost and manure are playing important role in enhancing the growth and quality of plants and onion is among them. However, there are some chemical factors which can inhibit the onion growth. As reported by Ansari, 2007 onions can be grown without heavy rainfall and extreme environment and can nicely grow in mild conditions under a wider range of climatic conditions. Therefore, the environmental condition plays the key role in productivity and yield of onion. In addition to the yield the quality of the onion which is grown is very important. As, the quality will decide various biochemical and medical property of onion. Onions are not only a part of food; they are used as a medicinal ingredient in different forms. It is widely famous as a condiment in all over globe mainly in Latin America, Africa, and Asia. Jila and Ghaffoor, 2003 reported that people use onion as an indispensable part of the human diet and are consumed both by rich and poor. Onion has taken place in everyone's kitchen irrespective of any class and economic status.

The economy is directly proportional to the quality, production and consumption of onion by the consumers. Tareke and Zena, 2008 have cited that since ancient times, onion has been of great economic importance for its medicinal and dietetic values. In addition, the they have reported the cultivar like Adama red, Melkam, Bombay red are well recognized and widely accepted for their good yielding potential. The flavor and color are also the point of attraction along with the taste of onion. As onions are eaten raw as well as as a part of cooked food, the flavor is at most important. Different cultivars have their own physical quality which makes onion more active. Onions can have mild or strong flavour, it may be white, pink or reddish pink in colour. Many cultivars have developed different colors and flavors for different regions of Northern and Southern Area (Tareke and Zena, 2008). Onions are good for health as they are rich in many therapeutic compounds. They are rich in many bioactive compounds which are responsible for medicinal property. Onions can be considered as good source of nutraceuticals because of its nutritional as well as antioxidant properties. Onions have antioxidant properties are important for its health beneficial activities and thereby contribute to its therapeutic characteristics (Lau et al., 1997 and Kyo et al., 1999).

Antioxidants are the compounds present in the food which helps to prevent and reduce oxidative damages to our body cells. These agents are able to counter the deleterious effects of free radicals (O_2, H_2O_2, $\cdot OH$) generated during respiration and metabolic process (Lobo et al., 2010). Free radicals can bind to nucleotides of DNA and RNA, oxidize proteins and lipids and therefore can damage cells. Plant cells generate sufficient number of enzymatic antioxidants such as superoxide dismutase, catalase, as corbate and glutathione peroxidase, glutathione reduct ase to combat the oxidative stresses(Kurutas, 2016). In recent times, a considerable focus has been given on the development and evaluation of natural antioxidants and free radical scavengers of plant materials or fruits that are enormously rich in polyphenolic compounds. Griffiths et al., 2002;Dini et al., 2008 and Singh et al., 2009 reported the antibacterial, antioxidant and anti mutagenic properties of onions. Beside these, onions also have the property to protect and reduce cardiovascular diseases and diabetes which were studied in animal models(Kumar et al., 2010). Growth of plant is proportional to the amount of nutrition, light, water and all the basic environmental conditions which can alter the growth rate. Different factors such as light, temperature, nutrients, oxygen supply and stimulants such as hormones are responsible for the growth of onion (Bulgari et al., 2019). In recent times, the soil lacks sufficient nutrients which are responsible for the better growth and development of crops and this is due to extensive

cultivation (White and Brown, 2010). Soil is the base from which onions can take and utilize the correct amount of nutrients. However, the addition of external nutrient can enhance the quali and yield of onions. In contrast, growth and yield can be inhibited by various contaminants and pollutants from the environment. Both organic and inorganic fertilizers are used to meet the nutrient demands of the crops. The release of phyto hormones from living organisms present in manure of soil is activated by organic manures and it also enhances the plant growth and nutrients absorption (Arisha et al., 2003). The comparable outcome was also described by (Boyhan et al., 2007). The root rhizospheres conditions are improved by the use of organic fertilizers (structure, humidity, etc.) which helps to promote root growth and thus encourages the growth of plants resulting in increase in the population of microorganisms (Khokhar, 2019). The decomposition of organic fertilizer is increased by the use of Organic acids which further increases the benefits of nutrients (Yoldas et al., 2011). Additionally, chemical fertilizers enhanced the growth of onion. Inspite of separate use of chemical or any bio fertilizer, the use of organic inputs in combination with chemical fertilizer was found better over the single(Mohanty et al., 2015). The present investigation was intended to analyze the influence of supplementation of fertilizers (both organic and inorganic fertilizer). Under these conditions, both oxidative stress and its anti-oxidative activities were studied. The impact of fertilizers on the genomic DNA contents, total soluble proteins, carbohydrates and fatty acids of *Allium cepa* were recorded. The enzymatic activity was also determined by ascorbate oxidase activity and catalase activity under the same conditions.

MATERIAL AND METHOD

Growth condition for onion
The bulb of Pusa Ratnar variety of onion was grown under controlled condition in the University campus. Different types of environmental growth conditions were used for analyzing the growth of onions. The control was grown in normal soil without addition of any fertilizer or chemicals. The other sets of onion were grown in different growth effecters like Manure, MOP (Muriate of potash), Urea, SSP (Single Superphosphate), Vermi compost, Normal (Water), Normal (Soil), Copper Sulphate of various concentrations in soil and water form, and 10mM HgCl$_2$ and 20mM HgCl$_2$ concentrations in soil.

Sample preparation
Leaves of onion grown under different stress conditions were dried in hot air oven at 50° C overnight and crushed and fine powder was used for sample preparation. Aqueous extract of the powder was prepared by using soxhlet apparatus and kept at -20^0 C for further analysis.

Total soluble carbohydrate
The estimation of total soluble carbohydrate was carried out as per the method given by (Clegg, 1956). The 0.05ml extract was digested with 2N HCl and neutralized followed by centrifugation at 8000 rpm for 5 min. The supernatant was collected and treated with Anthrone reagent. The absorbance was measured at 630 nm.

Total soluble protein
Total soluble protein was estimated as per the method of Abdul-Fadl (1949).0.05ml extract was treated with 5ml of solution C (50ml solution A: 2% sodium carbonate in 0.1N NaOH) + 1ml solution B: 0.5% CuSO4 in 1% sodium potassium tartrate) followed by addition of 0.5ml Folin-Ciocalteu reagent. The dispersion was mixed and incubated in dark for half an hour and absorbance was measured at 660nm.

Free fatty acid (acid value)
Free fatty acid was estimated as per the protocol of Pearson and Cox, 1962. 1ml of the extract was treated with 25ml of neutral solvent followed by addition of few drops of phenolphthalein and the resultant solution was titrated against 0.01N potassium hydroxide.

$$FFA \left(\frac{mgKOH}{ml}\right) = \frac{(Titre\ value\ \times Normality\ of\ KOH\ \times 56.1)}{(Amount\ of\ sample\ in\ ml)} \times 100$$

Crude fiber

The method of AOAC, 2005 was used for crude fibre content estimation. Defatted and fat free sample (2g) was transferred to pre -weighed capsules, fixed in the capsule tray and placed in extraction vessel (carousel). The sample was washed with boiling dilute H_2SO_4 (1.25% v/v) to remove carbohydrates till it turned transparent followed by washing with hot water to remove acid. The sample was then washed with (1.25%w/v) hot NaOH which was followed by hot water washing. Finally, capsule washing was done with petroleum ether (99%) to remove all organic compounds. It was followed by hot water washing. The capsules were then dried for 1-2 hrs in hot air oven at 100º C. Brought to room temperature & weighed. The percent loss in weight was expressed as crude fibre.

$$\%Crude\ Fibre = \frac{Loss\ in\ weight\ of\ sample - Loss\ in weight\ of\ blank}{Weight\ of\ sample} X100$$

Ash content

The method of AOAC 2005was followed for ash determination. Two gram of sample taken in a silica crucible was ignited on a heater and shifted to a muffle furnace until clean ash was obtained. The temperature of furnace was raised to 550º C ± 15º C. The weight of residue was noted and the percent ash was calculated as follows:

$$\%\ Ash = \frac{Weight\ of\ residue}{Weight\ of\ sample} x100$$

Assessment of antioxidant properties

The antioxidant activity of the extracts was determined by different enzymatic and non-enzymatic assays.

DPPH scavenging activity (%)

The antioxidant scavenging activity was estimated as per the method of Kekuda et al., 2016. The extract was prepared in methanol and DPPH was mixed with different concentration of fruit juice and incubated at room temperature for 30 min. The absorbance was studied at 517 nm. The scavenging activity of the extract was calculated using the following formula:

Scavenging activity (%) = [(A-B) /A] × 100

Where, A is the absorbance of DPPH and B is the absorbance of extract combination.

Total poly phenolic Content

The total phenolic content was estimated by the method of AOAC, 2011. 0.05ml of the extract was treated with folin-ciocalteau reagent followed by addition of 7% Na_2CO_3within 5 minutes and incubated in dark for 60 mins. The absorbance was recorded at 765 nm. The total polyphenol was calculated by following formula:

$$Polyphenol = \frac{(SampleOD - Intercept\ value)XSampleextractionvolume}{Slope\ X\ MassingmoftestsampleX10000Xwt.\ indrymatter} x100$$

Total antioxidant capacity (TAC)

The total antioxidant capacity was determined by the phosphor molybdenum method according to the procedure described by Prieto et al., 1999. 0.5ml of the extract was treated with 4.5ml of phosphor molybdenum reagent and was incubated at 90ºC for 90min. The optical density was measured at 695nm and ascorbic acid (0.25mg/ml) was used as a standard. Total antioxidant capacity was calculated by using the following formula:

$$Total\ antioxidant\ capacity(\%) = \{(As - Ac)/(Aaa - Ac)\}x100$$

Where Ac = control absorbance; As = sample absorbance; Aaa = Ascorbic acid absorbance

Ascorbic acid

Ascorbic acid content was estimated using titrimetric method (Barakat et al., 1952).By adding oxalic acid and titrated against the dye (V1: against the ascorbic acid & V2: against the sample extract), determination of end point can be

detected by tracking the appearance of slight pink colour which persists for few minutes. Amount of ascorbic acid (mg/100g sample) was calculated by using formula:

$$\frac{0.5 mg}{V1} X \frac{V2}{5ml} X \frac{100 ml}{Wt. of the sample} X 100$$

Assay of as corbate oxidase activity
As corbate oxidase activity was measured by following the method of Diallinas et al., 1997. Reaction mixture contained potassium buffer (pH 7) and ascorbic acid. The reaction was initiated with the addition of pure juice or different extracts. The decrease in absorbance was observed for 3min at 265nm due to as corbate oxidation and calculated using extinction coefficient $14mM^{-1}cm^{-1}$.

Assay of catalase activity
Catalase activity was determined by following the method of (Aebi, 1984). The reaction mixture contained potassium buffer (pH 7), extract and H_2O_2 to initiate the reaction. The reaction was measured at 240nm for 3min and H_2O_2 consumption was calculated using extinction coefficient $39.4mM^{-1} cm^{-1}$.

RESULTS AND DISCUSSION

Onion growth and yield is depended on the environmental condition in which it is grown. The positive and negative growth can be observed as reported in the present study (Figure 1). Organic and bio fertilizers are the key requirements for fast growth of onions in turn which shows high content of various bioactive compounds. The report of Shedeed et al., 2014 also suggests the improved quality of onion grown on bio fertilizer. In contrast the heavy metals which are the common pollutants lowers down the yield and biochemical property on onion. Protection of the environment is the most vital issue today. Sarma et al., 2001 reported that population fast rate growth, Science and technology fast growth, use of chemicals in agriculture etc. are some of the life-threatening factors. Masih and Bhadauria, (2010) reported that heavy metals compete with micronutrients and inhibit their uptake thus disturbing the growth and physiology of the plants. In the present study the treatment of onion with different growth environmental factors indicated variation in the growth patterns as heavy metals plays an important role in the growth and development of plant. Heavy metals form a major group of toxic pollutants as they have the potential to tamper the harmony of the ecosystem (Rao and Patnaik, 1999). The phyto chemical analysis of all the treated plants were performed and recorded in all the conditions. The effect of heavy meal in plants is the major cause of health issues because of biomagnification Consumption of food crops contaminated with heavy metals is a major food chain route for human exposure (Ashiq et al., 2013). The growth of the onion under different growth conditions was monitored using yield and biochemical quality attributes.

Nutritional Analysis
Total soluble carbohydrate content exhibits a lot of variation in treated samples of onion as indicated in Figure 2. Total soluble carbohydrate content recorded highest in onions grown on soil treated with MOP as 0.348mg/ml±0.2 mg/ml and the lowest level of total soluble carbohydrate was found to be 0.17±0.1 mg/ml in onions grown on soil treated with 50mM $CuSO_4$. Onions are the good source of carbohydrate. Yahaya et al., (2010)study on crude extract of onion bulb found to have carbohydrate content of 64.5±0.98(g/100g dry mass). Application of organic fertilizers and/or bio fertilizers to the soils promoted nutrients availability, plant uptake, increased crop yield and quality (Shaheen et al., 2007; Shedeed et al., 2014). The enhanced and reduced amount of carbohydrate in the treated onions may be due to increase and decrease rate of chlorophyll synthesis during photosynthesis. The total soluble protein content was recorded for all the treatments and a wide variation was recorded in the range from vermin compost and manure treated soils. However, the protein content of metal treated soil was more than the manure treated soil. The value of 0.069 ±0.0115 mg/ml in onions grown on vermin compost was highest among all the treatments and 0.0080±0.0040mg/ml, i.e. the lowest value was recorded in onions grown manure as depicted in the Figure3.Yahaya et al., (2010)on crude extract of onion reported 6.5±1.2 (g/100g dry mass off the protein content.

Free fatty acid content is expressed as oleic acid equivalent as indicated in the **Figure 4.** The lowest amount, of 0.3mg/ml was found in the onions grown in 10mM $HgCl_2$ treated soil and highest value of free fatty acid was recorded as 0.85mg/g in single super phosphate treated onions in soil. Study done by Ogbonna et al., (2016)showed total fat and saturated fat (0.17±0.01, 0.03±0.01). Organic manure contains nutrient elements that can support crop production and enhance chemical and physical properties of soil (Monira et al., 2019). The fat content is the major macromolecule which is the indication of nutritional quality of a food. Hence, the study showed a significant amount of fats in the form of free fatty acid which is the absorbable for of total fat. Total fiber content for all the treatments were recorded in wide variation. The highest value was found to be 1.82±0.008g in vermin composting and 0.91±0.061g was the lowest value recorded for50mMCuSO₄ treated water among all the treatments as shown in the **Figure 5.** Rahman et al., (2013)reported that 0.6g of fibre is present in onion and it is also a good source of various macromolecules including vitamins and minerals. Samples with higher amount of crude fibre improve protection against constipation and it also prevents cardiovascular disease because studies have shown that soluble fibre lowers levels of artery-clogging cholesterol in the blood stream (Krishnamurthy et al., 2012).

The ash content among all the treatments was also found to be significant. The highest and lowest values were recorded as 3.62±0.009g and 1.81±0.005g in 20mM$HgCl_2$ treated soil and Normal soil respectively as noted in the Figure 6. Dinkecha and Muniye, (2017)reported that red onions are good source of nutrition and they are rich in ash content. Onion bulbs used in the study infect have high levels of ash, fiber and protein, but comparatively low moisture content, carbohydrate and energy value. Ash content is very important parameter for estimating the inorganic mineral constituent of Onion. High content of ash is important in that it involves higher value of inorganic material (Dinkecha and Muniye, 2017).

Antioxidant profiling

In order to access the antioxidant property of the grown onions at different growth conditions both the non-enzymatic and enzymatic assays were performed. The scavenging activity were recorded in a wide variation The DPPH free radical scavenging activity was found to be 82.5% which is highest in onions treated with vermicompost treated soil and lowest scavenging value of 32.1% was recorded in onions treated with 10mM $HgCl_2$ treated soil in the **Figure 7.** Liguori et al., (2017)reported the antioxidant activity varied from 19.00 to 21.27 mg of extract/m in five different white landraces of *Allium cepa.* Liguori et al., (2017) also reported the importance of phenolics and flavonoids in human health. The bioactive compounds which are rich in antioxidants are important to fight against the free radicals and protect human from different health problems. The work of Fredotovíc et al., (2017) in two species of *Allium* i.e. *Allium cepa and Alluim cornutum* showed that DPPH activity is higher on methanolic extract at the concentration of 100μg/ml which was reported as 64.8±5.3 and 60.50±3.8 for *Allium cepa and Alluim cornutum* respectively. The DPPH assay is the common method which is followed by for different varieties of plant extracts. Total antioxidant activity of pomegranate juice was determined by the 1,1-diphenyl-2-picrylhydrazyl (DPPH) method(Elfalleh et al., 2009). However, Total Antioxidant Capacity (TAC) is equally important to access the scavenging activity of plant extracts. The Total Antioxidant Capacity (%) is shown in the **Figure 8.**

Among all the treatments, 79.1% of highest TAC was observed in muriate of potash (MOP) treated onions and 6.5% was recorded as lowest value of TAC in 50mM CuSO₄ water treated onions. The antioxidant activity of onion skin is also important in addition to the antioxidant properties bulb and leaf. The study of Stoica et al., 2021 on the skin of red onion variety after 30 min of reaction reported antioxidant activity of 436.25 ± 3.51 mM TE/g DW. The physical treatments are also reported to check the antioxidant property of onion. The ultrasound treated onions were also found to have antioxidant property. Antioxidant activity (490.54 ± 9.43 mM TE/g DW) for the ultrasounds treated red onion skins extract was determined by Prokopov et al., (2018). Antioxidants are of endogenous and exogeneous types. The antioxidants are abundant in natural products. Several studies reported the antioxidant activities of *A. cepa* and its constituents and introduced the plant as a potential source of natural antioxidants (Razavi and Kenari, 2016; Ola-Mudathir and Maduagwu, 2014). Some of the important enzymes are key indicators or antioxidant property of plant. Superoxide dismutase and catalase are two of the main enzymatic antioxidants.

The main activity of SOD is to dismute the superoxide anion to hydrogen peroxide, which is reduced by CAT to water and molecular oxygen (Galadari et al., 2017), thereby preventing the formation of a highly reactive hydroxyl radical (HO·) (Lubrano, 2015). The ascorbic acid content was recorded in wide range as shown in **Figure 9.**The ascorbic acid concentration was maximum at vermicompost treated soil and minimum at 50mM $CuSO_4$(0.6±0.04 μg/ml and 0.07±0.009 μg/ml respectively. Kandoliya et al., (2015) reported worked on different varieties of onions and reported ascorbic acid (1.18 to 3.89 mg.100g-1) of ascorbic acid along with other nutritional assays. Ascorbic acid is one of the important vitamins which contribute for the antioxidant property in any plant. Phytonutrients like phenolics and flavanoids present in onion have been found to act as antioxidants to lower blood pressure and prevent some kinds of cancer(Yang et al., 2004; Slimestad et al., 2007).Ascorbate oxidase activity as depicted in Figure 10.The highest value is recorded in normal soil grown onion and lowest in 20mM $HgCl_2$ treated soil which was recorded 1.2±0.03 and 0.03±0.004 respectively. **Figure11**.explains the catalase activity of the treated onions and was found to be lowest among 10mM $HgCl_2$ treated soil onions and highest in onion grown in normal water which is recorded as 0.001 ±0.0003 and 0.167±0.002 respectively. The work of Ece et al., 2007 on Banko, Kes, Valencia and Kapidag have also reported the high catalase activity.

CONCLUSION

The current study has shown the effect of various environmental conditions on various biochemical properties and yield of onion. Based on the study it can be said that vermin compost and manure are the growth supplements for onion growth. Its application can increase the nutraceutical property of onion leaf. In addition, the information regarding the application of various metal treatments is also of great concern as their application can inhibit the health beneficial property of onion. Hence, to enhance the sufficient onion production the use of vermin compost can be recommended. The soil having heavy metals can be checked and avoided to increase the growth yield. It is evident that the presence of heavy metals has many toxic effects on plant physiology and its growth. Thus, it can be concluded that there is a need of intensifying the programs which are involved in the study related to the use of vermin compost and related bio fertilizers, heavy metal toxicity on plants and to prevent environmental stresses.

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CONFLICT OF INTEREST
The authors declare that there is no conflict of interest.

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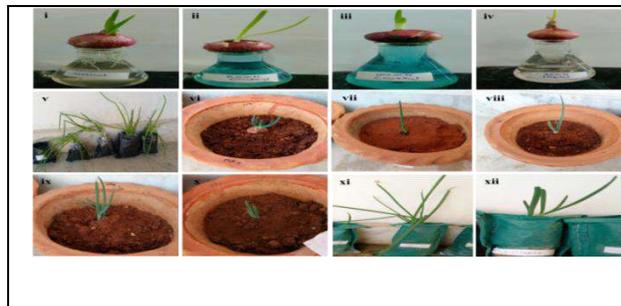
Fig 1: Onion growth in different environmental growth conditions. i: onion grown in normal condition; ii: onion treated with 50 mM CuSO₄(w); iii: onion treated with 100 mM CuSO₄(w); iv: onion treated with 20 mM HgCl₂(w); v:onion treated with 50 mMCuSO₄(s); vi: onion treated with Manure (s); vii: onion treated with MOP (s); viii: onion treated with Urea; ix: onion treated with SSP (s); x:onion treated with Vermi composting (s); xi: onion treated with 70 mMCuSO₄(s); and xii: onion treated with10 mM HgCl₂(s).
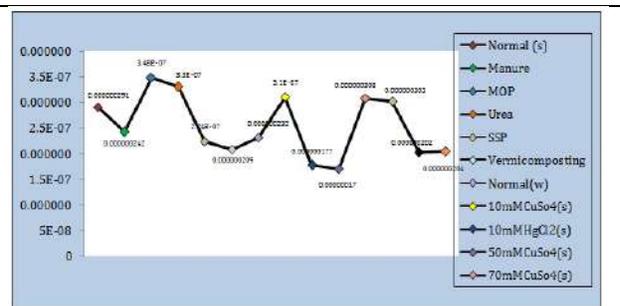
Fig2: Total soluble carbohydrate of onion (mg/ml).
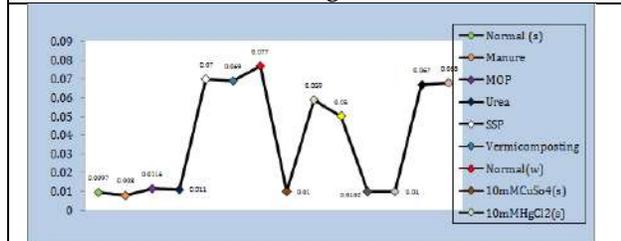
Fig 3: Total soluble protein of onion (mg/ml).
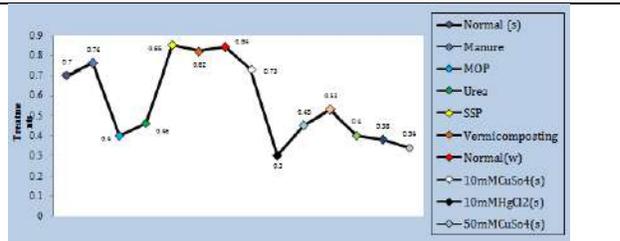
Fig 4: Free Fatty Acid of onion (mg/ml).

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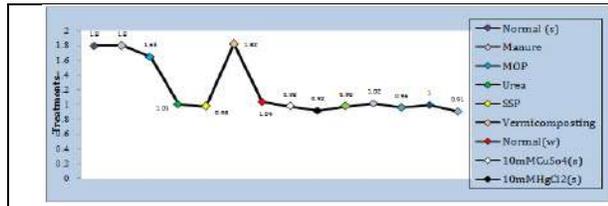
Fig 5: Total fiber content of onion(g/100g)
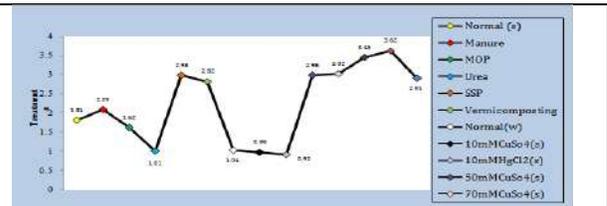
Fig 6: Ash content of onion(g/100mg)
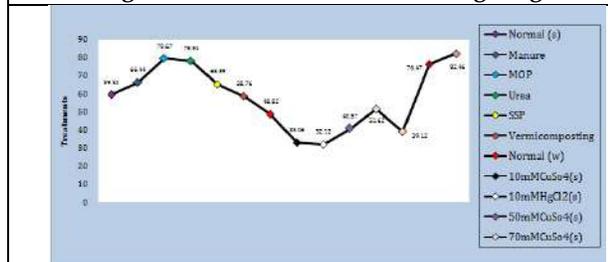
Fig 7: DPPH scavenging activity (%) of onion
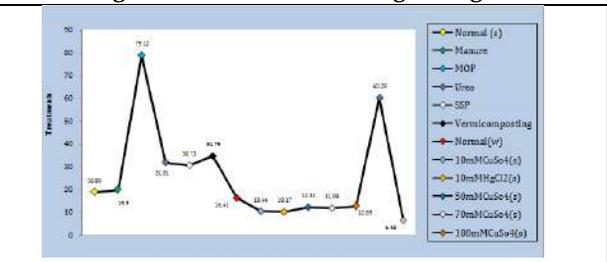
Fig 8: Total Antioxidant Capacity (%) of onion
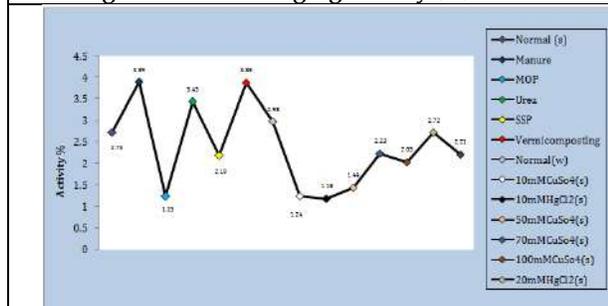
Fig 9: Ascorbic acid content(g/100g) of onion
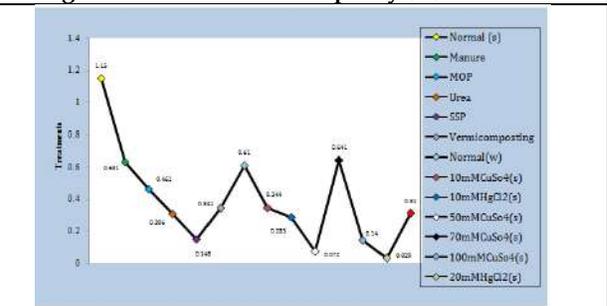
Figure 10: Ascorbate oxidase activity of onion
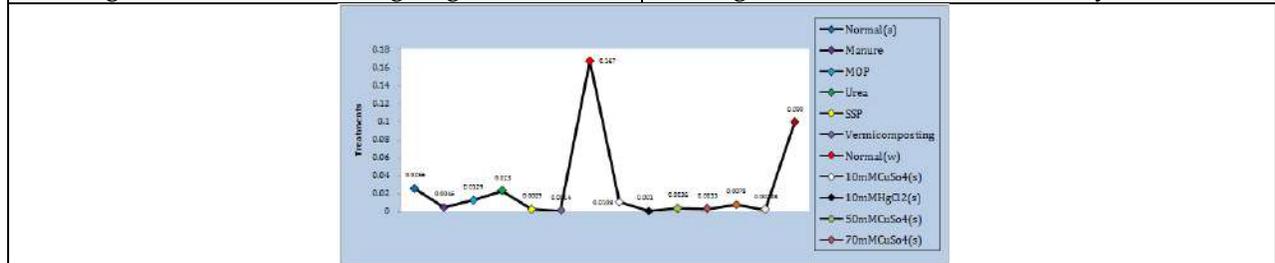
Fig 11: Catalase activity of onion

RESEARCH ARTICLE

The Nano Form of δ*-Closed Sets in Nano Ideal Topological Spaces

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ABSTRACT

The present work investigates the δ*-closed sets in nano ideal topological space using the ñδ*-local function $S_{ñδ*}(I, N) = \{x \in U: \text{n-int(n-cl}_δ(O_n)) \cap S \notin I \text{ for every } O_n \in N(x)\}$ and ñδ*-closure operator defined by: $cl_{ñδ*}(S) = S \cup S_{ñδ*}$. We extensively study the properties of both $S_{ñδ*}(I, N)$ and $cl_{ñδ*}(S)$. We establish that $cl_{ñδ*}(S)$ follows the kuratowski conditions so that the set discuss here forms topology. Further, we introduce the notions ñδ*-interior, ñδ*-closure, ñδ*-exterior, ñδ*-frontier, ñδ*-derived set and ñδ*-border and discuss its various properties.

Keywords: ideal topological space, nano ideal topological space, ñδ*-closure function, ñδ*-closed sets, ñδ*-open sets.

1. INTRODUCTION

Kuratowski [4] and Vaidhyanathaswamy [10] initiated and studied the concept of ideals in topological spaces. A non-empty sub-collection I of P(U) is called an ideal [4] if it satisfies: (i) Heredity: S ∈ I and T ⊆ S implies T ∈ I, and (ii) Finite additivity: S ∈ I and T ∈ I implies S ∪ T ∈ I. For a given topological space (U, τ) combined with ideal I the local function [2, 10] $(.)^*$: P(U) → P(U), $S^*(I, τ) = \{x ∈ U: O ∩ S ∉ I$, for every O ∈ τ, x ∈ O} and the Kuratowski closure operator $cl^*(S) = S ∪ S^*(I, τ)$ for S ⊆ U were studied extensively. The topology obtained by establishing these operators are called $*$-topology or simply $τ^*$ which is finer than τ and the open sets belonging to $τ^*$ are called $*$-open sets. Dontchev and Ganster [1] studied further properties and applications in various fields of the ideal topology. In 2013, Lellis Thivagar et.al [3] introduced the field of nano topology denoted by the pair (U, N) in terms of the theory approximations on X ⊆ U using the equivalence relation called indiscernibility relation on it. The open sets in (U, N) are called the nano open sets and associated closed sets are nano closure. M. Parimala et.al., [5, 6, 7] introduced nano ideal topological space by defining the local function S_n^* called nano local function by: $S_n^*(I, N) = \{x ∈ U: O_n ∩ S ∉ I$, for every $O_n ∈ O_n(x)\}$ where $O_n(x) = \{O_n: x ∈ O_n$ and O_n is n-open} and the closure operator $cl_n^*(S) = S ∪ S_n^*(I, N)$ for S ⊆ U and established its significant properties. We simply write S_n^* for $S_n^*(I, N)$. The topology obtained through these operator is known as the nano ideal topological space mentioned by (U, N, I). After this the nano form of several existing closed and open sets were studied by the researchers in nano ideal topological space. We simply denote a nano ideal topological space as NITS. For instance Parimala et.al, [8] established and studied the nano form of δ-open sets namely nδ-closed set in the same space. A subset S of U is known as nδ-closed if $n\text{-}cl_δ(S) = S$, where $n\text{-}cl_δ(S) = ∪ \{x ∈ U: n\text{-}int(n\text{-}cl(O_n)) ∩ S ≠ ∅, O_n$ is n-open and $x ∈ O_n\}$. In this article we introduce and investigate the nano form of δ*-closed [9] sets in nano ideal topological space. Further we introduce and study the notions ñδ*-interior, ñδ*-closure, ñδ*-exterior, ñδ*-frontier, ñδ*-derived set and ñδ*-border of a subset of U.

2. ñδ*-OPEN SETS

2.1 Definition

Let (U, N, I) be an NITS and S ⊆ U. An operator called nano local δ*- closure function of S simply $S_{ñδ^*}$ with respect to I and N is defined by $S_{ñδ^*}(I, N) = \{x ∈ U: n\text{-}int(n\text{-}cl_δ(O_n)) ∩ S ∉ I$ for every $O_n ∈ N(x)\}$. Where $N(x) = \{O_n: O_n$ is n-open, x ∈ O_n}. We simply write $S_{ñδ^*}(I, N)$ by $S_{ñδ^*}$. For Example, Let U = {g_1, g_2, g_3, g_4}, X = {g_1, g_4} ⊆ U, U/R = {{g_2}, {g_4}, {g_1, g_3}}, N = {U, ∅,{g_4}, {g_1, g_3, g_4}, {g_1, g_3}} and the ideal I = {∅, {g_2}}. Take S = {g_1} then $S_{ñδ^*}$ = {g_1, g_3}.

2.2 Remark

Always, $∅_{ñδ^*} = ∅$. In general neither $S ⊆ S_{ñδ^*}$ nor $S_{ñδ^*} ⊆ S$.

2.3 Theorem

Let (U, N, I) be an NITS with ideals I_1 and I_2 on U. Then for S, T ⊆ U, the given below are holds:

(i) $∅_{ñδ^*} = ∅$.

(ii) If S ⊆ T, then $S_{ñδ^*} ⊆ T_{ñδ^*}$.

(iii) $S_{ñδ^*} = n\text{-}cl(S_{ñδ^*})$, $S_{ñδ^*}$ is n-closed.

(iv) If S ∈ I then $S_{ñδ^*} = ∅$.

(v) If $I_1 ⊆ I_2$ then $S_{ñδ^*}(I_2) ⊆ S_{ñδ^*}(I_1)$.

(vi) $(S ∪ T)_{ñδ^*} = S_{ñδ^*} ∪ T_{ñδ^*}$.

(vii) $(S ∩ T)_{ñδ^*} ⊆ S_{ñδ^*} ∩ T_{ñδ^*}$.

(viii) $(S_{ñδ^*})_{ñδ^*} ⊆ S_{ñδ^*}$.

Proof

(i) The proof is clear.

(ii) Suppose that $x ∉ T_{ñδ^*}$. Then there is an $O_n ∈ N(x)$ such that $T ∩ n\text{-}int(n\text{-}cl_δ(O_n)) ∈ I$. Since, S ⊆ T, $(S ∩ n\text{-}int(n\text{-}cl_δ(O_n))) ⊆ (T ∩ n\text{-}int(n\text{-}cl_δ(O_n))) ∈ I$ and hence $S ∩ n\text{-}int(n\text{-}cl_δ(O_n)) ∈ I$, $x ∉ S_{ñδ^*}$. A contradiction. Hence, $S_{ñδ^*} ⊆ T_{ñδ^*}$.

(iii) We have $S_{ñδ^*} ⊆ n\text{-}cl(S_{ñδ^*})$. Let $x ∈ n\text{-}cl(S_{ñδ^*})$. Then $O_n ∩ S_{ñδ^*} ≠ ∅$, for every $O_n ∈ N(x)$ and hence $n\text{-}int(n\text{-}cl_δ(O_n)) ∩ S_{ñδ^*} ≠ ∅$. Therefore, there exists a $y ∈ n\text{-}int(n\text{-}cl_δ(O_n)) ∩ S_{ñδ^*}$. Since $y ∈ S_{ñδ^*}$, $n\text{-}int(n\text{-}cl_δ(O_n)) ∩ S ∉ I$ and hence $x ∈ S_{ñδ^*}$.

(iv) Suppose that $x \in S_{ñδ*}$. Then for any $O_n \in N(x)$, $S \cap$ n-int(n-cl$_\delta$(O_n)) $\notin I$. But since $S \in I$, $S \cap$ n-int(n-cl$_\delta$(O_n)) $\in I$ for every $O_n \in N(x)$. There is a contradiction. Hence, $S_{ñδ*} = \emptyset$.

(v) If $x \notin S_{ñδ*}(I_1)$. There is an $O_n \in N(x)$ with $S \cap$ n-int(n-cl$_\delta$(O_n)) $\in I_1$. Since $I_1 \subseteq I_2$, $S \cap$ n-int(n-cl$_\delta$(O_n)) $\in I_2$ and $x \notin S_{ñδ*}(I_2)$. Therefore, $S_{ñδ*}(I_2) \subseteq S_{ñδ*}(I_1)$.

(vi) By (ii), $S_{ñδ*} \cup T_{ñδ*} \subseteq (S \cup T)_{ñδ*}$. Now, let $x \in (S \cup T)_{ñδ*}$. Then for every $O_n \in N(x)$, (n-int(n-cl$_\delta$(O_n)) $\cap S$) $\cup$ (n-int(n-cl$_\delta$(O_n)) $\cap T$) = ($S \cup T$) $\cap$ (n-int(n-cl$_\delta$(O_n))) $\notin I$. Therefore, n-int(n-cl$_\delta$(O_n)) $\cap S \notin I$ or n-int(n-cl$_\delta$(O_n)) $\cap T \notin I$. Hence $x \in S_{ñδ*} \cup T_{ñδ*}$.

(vii) The proof is clear by (ii).

(viii) Let $x \in (S_{ñδ*})_{ñδ*}$. Then for every $O_n \in N(x)$, n-int(n-cl$_\delta$(O_n)) $\cap S_{ñδ*} \notin I$ and hence n-int(n-cl$_\delta$(O_n)) $\cap S_{ñδ*} \neq \emptyset$. Let $y \in$ n-int(n-cl$_\delta$(O_n)) $\cap S_{ñδ*}$. Then $y \in$ n-int(n-cl$_\delta$(O_n)) and $y \in S_{ñδ*}$. Therefore, n-int(n-cl$_\delta$(O_n)) $\cap S \notin I$ and hence $x \in S_{ñδ*}$. The given below Example 2.4 illustrates the Theorem 2.3 (vii) do not imply the reverse.

2.4 Example

Let $U = \{g_1, g_2, g_3, g_4\}$, $X = \{g_1, g_4\} \subseteq U$, $U/R = \{\{g_2\}, \{g_4\}, \{g_1, g_3\}\}$, $N = \{U, \emptyset, \{g_4\}, \{g_1, g_3, g_4\}, \{g_1, g_3\}\}$ and the ideal $I = \{\emptyset, \{g_2\}\}$. Let $S = \{g_2, g_4\}$, $T = \{g_1, g_2, g_3\}$ then $S \cap T = \{g_2\}$, $S_{ñδ*} = \{g_2, g_4\}$, $T_{ñδ*} = \{g_1, g_2, g_3\}$, $S_{ñδ*} \cap T_{ñδ*} = \{g_2\}$ and $(S \cap T)_{ñδ*} = \emptyset$. Therefore, $(S \cap T)_{ñδ*} \not\supseteq S_{ñδ*} \cap T_{ñδ*}$.

2.5 Theorem

[7] In an NITS (U, N, I) the ñδ*-closure operator cl$_{ñδ*}$(S) = $S_{ñδ*} \cup S$, satisfies the following for S, T $\subseteq$ U:

(i) cl$_{ñδ*}(\emptyset) = \emptyset$ and cl$_{ñδ*}$(U) = U.

(ii) $S \subseteq$ cl$_{ñδ*}$(S).

(iii) If $S \subseteq T$ then cl$_{ñδ*}$(S) $\subseteq$ cl$_{ñδ*}$(T).

(iv) cl$_{ñδ*}$(S $\cup$ T) = cl$_{ñδ*}$(S) $\cup$ cl$_{ñδ*}$(T).

(v) cl$_{ñδ*}$(S $\cap$ T) $\subseteq$ cl$_{ñδ*}$(S) $\cap$ cl$_{ñδ*}$(T).

(vi) cl$_{ñδ*}$(cl$_{ñδ*}$(S)) $\subseteq$ cl$_{ñδ*}$(S).

Proof

(i) cl$_{ñδ*}(\emptyset) = \emptyset_{ñδ*} \cup \emptyset = \emptyset$ and cl$_{ñδ*}$(U) = $U_{ñδ*} \cup U$.

(ii) $S \subseteq S_{ñδ*} \cup S =$ cl$_{ñδ*}$(S).

(iii) Let $S \subseteq T$, cl$_{ñδ*}$(S) = $S_{ñδ*} \cup S \subseteq T_{ñδ*} \cup T =$ cl$_{ñδ*}$(T), by Theorem 2.3 (ii).

(iv) By Theorem 2.3 (vi), cl$_{ñδ*}$(S $\cup$ T) = (S $\cup$ T)$_{ñδ*} \cup$ (S $\cup$ T) = ($S_{ñδ*} \cup T_{ñδ*}$) $\cup$ (S $\cup$ T) = ($S_{ñδ*} \cup$ S) $\cup$ ($T_{ñδ*} \cup$ T) = cl$_{ñδ*}$(S) $\cup$ cl$_{ñδ*}$(T).

(v) Since $S \cap T \subseteq S$ and $S \cap T \subseteq T$ then by (iii), cl$_{ñδ*}$(S $\cap$ T) $\subseteq$ cl$_{ñδ*}$(S) and cl$_{ñδ*}$(S $\cap$ T) $\subseteq$ cl$_{ñδ*}$(T) and hence cl$_{ñδ*}$(S $\cap$ T) $\subseteq$ cl$_{ñδ*}$(S) $\cap$ cl$_{ñδ*}$(T).

(vi) cl$_{ñδ*}$(cl$_{ñδ*}$(S)) = cl$_{ñδ*}$($S_{ñδ*} \cup$ S) = ($S_{ñδ*} \cup$ S)$_{ñδ*} \cup$ ($S_{ñδ*} \cup$ S) = (($S_{ñδ*}$)$_{ñδ*} \cup S_{ñδ}$) $\cup$ ($S_{ñδ*} \cup$ S) = $S_{ñδ*} \cup$ ($S_{ñδ*} \cup$ S) = $S_{ñδ*} \cup$ S = cl$_{ñδ*}$(S) by Theorem 2.3 (vi) and (viii).

2.6 Remark

By Theorem 2.5, (i), (ii), (v) and (vi) cl$_{ñδ*}$(S) = $S_{ñδ*} \cup$ S forms topology. The topology created by cl$_{ñδ*}$(S) is indicated and defined by $N_{ñδ*} = \{O_{nδ*} \subseteq U:$ cl$_{ñδ*}$(U $- O_{nδ*}$) = U $- O_{nδ*}\}$. If $O_{nδ*} \in N_{ñδ*}$ then $O_{nδ*}$ is a ñδ*-open set and U $- O_{nδ*}$ is ñδ*-closed set. We denote $N_{ñδ*}$(x) = $\{O_{nδ*}: O_{nδ*}$ is ñδ*-open and $x \in O_{nδ*}\}$. The given example 2.7 (i) and (ii) reveals that the reverse implication of Theorem 2.5 (iii) and (v) fails in some time.

2.7 Example

Let $U = \{g_1, g_2, g_3, g_4\}$, $X = \{g_1, g_4\} \subseteq U$, $U/R = \{\{g_2\}, \{g_4\}, \{g_1, g_3\}\}$, $N = \{U, \emptyset, \{g_4\}, \{g_1, g_3, g_4\}, \{g_1, g_3\}\}$ and the ideal $I = \{\emptyset, \{g_2\}\}$.

(i) Let $S = \{g_1, g_4\}$ and $T = \{g_1, g_2, g_3\}$ then cl$_{ñδ*}$(S) = \{U\} and cl$_{ñδ*}$(T) = \{g_1, g_2, g_3\}. Therefore, cl$_{ñδ*}$(T) $\not\supseteq$ cl$_{ñδ*}$(S).

(ii) Let $S = \{g_1\}$, $T = \{g_2\}$. Then $S \cap T = \{\emptyset\}$, cl$_{ñδ*}$(S) = \{g_1, g_2, g_3\}, cl$_{ñδ*}$(T) = \{g_2\}, cl$_{ñδ*}$(S) $\cap$ cl$_{ñδ*}$(T) = \{g_2\} and cl$_{ñδ*}$(S $\cap$ T) = \{$\emptyset$\}. Therefore, cl$_{ñδ*}$(S $\cap$ T) $\not\supseteq$ cl$_{ñδ*}$(S) $\cap$ cl$_{ñδ*}$(T).

2.8 Definition

Let (U, N, I) be an NITS and $S \subseteq U$. A point $x \in U$ is known as a ñδ*-accumulation point of S if for each $O_{nδ*} \in N_{ñδ*}$(x), $O_{nδ*} \cap (S - \{x\}) \neq \emptyset$. The collection of all ñδ*-accumulation points of S is called ñδ*-derived set of S. We simply write dr$_{ñδ*}$(S).

2.9 Theorem

Let S, T be the subsets of U, the given below are hold:

(i) If $S \subseteq T$, then $dr_{ñδ*}(S) \subseteq dr_{ñδ*}(T)$.

(ii) $dr_{ñδ*}(S) \cup dr_{ñδ*}(T) \subseteq dr_{ñδ*}(S \cup T)$.

(iii) $dr_{ñδ*}(S \cap T) \subseteq dr_{ñδ*}(S) \cap dr_{ñδ*}(T)$.

(iv) $dr_{ñδ*}(dr_{ñδ*}(S)) - S \subseteq dr_{ñδ*}(S)$.

Proof

(i) If $x \notin dr_{ñδ*}(T)$ then x is not a ñδ*-accumulation point of T and so there is a ñδ*-open set $O_{nδ*}$ with $O_{nδ*} \cap (T - \{x\}) = \emptyset$. But $O_{nδ*} \cap (S - \{x\}) \subset O_{nδ*} \cap (T - \{x\}) = \emptyset$. Hence, $x \notin dr_{ñδ*}(S)$.

(ii) Since $S \subseteq S \cup T$ and $T \subseteq S \cup T$ by (i), $dr_{ñδ*}(S) \subseteq dr_{ñδ*}(S \cup T)$ and $dr_{ñδ*}(T) \subseteq dr_{ñδ*}(S \cup T)$. Hence $dr_{ñδ*}(S) \cup dr_{ñδ*}(T) \subseteq dr_{ñδ*}(S \cup T)$.

(iii) Since $S \cap T \subseteq S$ and $S \cap T \subseteq T$ again by (i) the proof is completes.

(iv) If $x \in dr_{ñδ*}(dr_{ñδ*}(S)) - S$ and $O_{nδ*} \in N_{ñδ*}(x)$ then $O_{nδ*} \cap (dr_{ñδ*}(S) - \{x\}) \neq \emptyset$. Let $y \in O_{nδ*} \cap (dr_{ñδ*}(S) - \{x\})$. Since $y \in (dr_{ñδ*}(S) - \{x\})$ and $y \in O_{nδ*}$, $(S - \{y\}) \cap O_{nδ*} \neq \emptyset$. Let $z \in (S - \{y\}) \cap O_{nδ*}$. Then $x \neq z$ for $x \notin S$ and $z \in S$. Therefore $x \in dr_{ñδ*}(S)$. The given below Example 2.10 illustrates that the reverse implication of the Theorem 2.9 (iv) is fails in some time.

2.10 Example

Let $U = \{g_1, g_2, g_3, g_4\}$, $X = \{g_1, g_4\} \subseteq U$, $U/R = \{\{g_2\}, \{g_4\}, \{g_1, g_3\}\}$, $N = \{U, \emptyset, \{g_4\}, \{g_1, g_3, g_4\}, \{g_1, g_3\}\}$ and the ideal $I = \{\emptyset, \{g_2\}\}$. Take $S = \{g_2, g_4\}$. Then $dr_{ñδ*}(dr_{ñδ*}(S)) - S \nsupseteq dr_{ñδ*}(S)$.

2.11 Definition

A point $x \in U$ is known as a ñδ*-interior point of S if there exist $O_{nδ*} \in N_{ñδ*}(x)$ such that $O_{nδ*} \subseteq S$. The collection of all ñδ*-interior points of S is said to be ñδ*-interior of S. We simply write $int_{ñδ*}(S)$.

2.12 Theorem

Let $S, T \subseteq U$, the given below are true:

(i) $int_{ñδ*}(S)$ is the for most ñδ*-open set contained in S.

(ii) S is ñδ*-open set $\Leftrightarrow S = int_{ñδ*}(S)$.

(iii) $int_{ñδ*}(int_{ñδ*}(S)) = int_{ñδ*}(S)$.

(iv) $int_{ñδ*}(S) = S - dr_{ñδ*}(U - S)$.

(v) $U - int_{ñδ*}(S) = cl_{ñδ*}(U - S)$.

(vi) If $S \subseteq T$, then $int_{ñδ*}(S) \subseteq int_{ñδ*}(T)$.

(vii) $int_{ñδ*}(S) \cup int_{ñδ*}(T) \subseteq int_{ñδ*}(S \cup T)$.

(viii) $int_{ñδ*}(S) \cap int_{ñδ*}(T) \supseteq int_{ñδ*}(S \cap T)$

Proof

(i) Let $O_{nδ*}$ be a ñδ*-open subset of S and if $x \in O_{nδ*}$ then $x \in O_{nδ*} \subseteq S$. Since $O_{nδ*}$ is ñδ*-open set, x is the ñδ*-interior point of S. Therefore, for $x \in O_{nδ*}$ implies that $x \in int_{ñδ*}(S)$. This implies that every ñδ*-open subset of S is contained in $int_{ñδ*}(S)$. Therefore, $int_{ñδ*}(S)$ is the for most ñδ*-open set contained in S.

(ii) Necessity: Let S be a ñδ*-open set. Since $S \subseteq S$, S is the for most ñδ*-open subset of S. Hence the proof completes by (i).

Sufficiency: Let $S = int_{ñδ*}(S)$. Since $int_{ñδ*}(S)$ is ñδ*-open set, the proof is clear.

(iii) Since $int_{ñδ*}(S)$ is ñδ*-open set, the proof is clear by (ii).

(iv) If $x \in S - dr_{ñδ*}(U - S)$, then $x \notin dr_{ñδ*}(U - S)$. Therefore there is an $O_{nδ*} \in N_{ñδ*}(x)$ for which $(U - S) \cap O_{nδ*} = \emptyset$. Then $x \in O_{nδ*} \subseteq S$ and so $x \in int_{ñδ*}(S)$. Therefore, $S - dr_{ñδ*}(U - S) \subseteq int_{ñδ*}(S)$. Alternatively, If $x \in int_{ñδ*}(S)$, then $x \notin dr_{ñδ*}(U - S)$, since $int_{ñδ*}(S)$ is ñδ*-open set and $int_{ñδ*}(S) \cap (U - S) = \emptyset$. Hence, $int_{ñδ*}(S) \subseteq S - dr_{ñδ*}(U - S)$. Therefore, $int_{ñδ*}(S) = S - dr_{ñδ*}(U - S)$.

(v) $U - int_{ñδ*}(S) = U - (S - dr_{ñδ*}(U - S)) = (U - S) \cup dr_{ñδ*}(U - S) = cl_{ñδ*}(U - S)$.

(vi) Let $S \subseteq T$. Then $x \in int_{ñδ*}(S)$ implies that there is an $O_{nδ*} \in N_{ñδ*}(x)$ with $x \in O_{nδ*} \subseteq S$. Therefore, $x \in O_{nδ*} \subseteq S \subseteq T$ that is $x \in O_{nδ*} \subseteq T$. Hence $x \in int_{ñδ*}(S)$.

(vii) Since $S \subseteq S \cup T$ and $T \subseteq S \cup T$ by (vi), $\text{int}_{ñδ^*}(S) \subseteq \text{int}_{ñδ^*}(S \cup T)$ and $\text{int}_{ñδ^*}(T) \subseteq \text{int}_{ñδ^*}(S \cup T)$. Therefore $\text{int}_{ñδ^*}(S) \cup \text{int}_{ñδ^*}(T) \subseteq \text{int}_{ñδ^*}(S \cup T)$.

(viii) Since $S \cap T \subseteq S$ and $S \cap T \subseteq T$, the proof is clear by (vi).

2.13 Definition

$\text{br}_{ñδ^*}(S) = S - \text{int}_{ñδ^*}(S)$ is said to be the ñδ*-border of S.

2.14 Theorem

Let (U, N, I) be an NITS. Then for $S \subseteq U$.

(i) $\text{int}_{ñδ^*}(S) \cap \text{br}_{ñδ^*}(S) = \emptyset$.

(ii) S is ñδ*-open set $\Leftrightarrow$ $\text{br}_{ñδ^*}(S) = \emptyset$.

(iii) $\text{br}_{ñδ^*}(\text{int}_{ñδ^*}(S)) = \emptyset$.

(iv) $\text{int}_{ñδ^*}(\text{br}_{ñδ^*}(S)) = \emptyset$.

(v) $\text{br}_{ñδ^*}(\text{br}_{ñδ^*}(S)) = \text{br}_{ñδ^*}(S)$.

(vi) $\text{br}_{ñδ^*}(S) = S \cap \text{cl}_{ñδ^*}(U - S)$.

(vii) $\text{br}_{ñδ^*}(S) = \text{dr}_{ñδ^*}(U - S)$.

Proof

(i) $\text{int}_{ñδ^*}(S) \cap \text{br}_{ñδ^*}(S) = \text{int}_{ñδ^*}(S) \cap (S - \text{int}_{ñδ^*}(S)) = \text{int}_{ñδ^*}(S) \cap (S \cap (U - \text{int}_{ñδ^*}(S))) = \text{int}_{ñδ^*}(S) \cap \emptyset = \emptyset$.

(ii) The proof is obvious.

(iii) $\text{br}_{ñδ^*}(\text{int}_{ñδ^*}(S)) = \text{int}_{ñδ^*}(S) - \text{int}_{ñδ^*}(\text{int}_{ñδ^*}(S)) = \text{int}_{ñδ^*}(S) - \text{int}_{ñδ^*}(S) = \emptyset$.

(iv) If $x \in \text{int } ñδ^* (\text{br } ñδ^* (S))$, then $x \in \text{br } ñδ^* (S)$. Since $\text{br } ñδ^* (S) \subseteq S$, $x \in \text{int } ñδ^* (\text{br } ñδ^* (S)) \subseteq \text{int } ñδ^* (S)$. Hence $x \in \text{int } ñδ^* (S) \cap (\text{br } ñδ^* (S)$, which contradicts (i). Thus $\text{int } ñδ^* (\text{br } ñδ^* (S)) = \emptyset$.

(v) $\text{br}_{ñδ^*}(\text{br}_{ñδ^*}(S)) = \text{br}_{ñδ^*}(S) - \text{int}_{ñδ^*}(\text{br}_{ñδ^*}(S)) = \text{br}_{ñδ^*}(S)$.

(vi) $\text{br}_{ñδ^*}(S) = S - \text{int}_{ñδ^*}(S) = S - (U - \text{cl}_{ñδ^*}(U - S)) = S \cap \text{cl}_{ñδ^*}(U - S)$.

(vii) $\text{br}_{ñδ^*}(S) = S - \text{int}_{ñδ^*}(S) = S - (U - \text{dr}_{ñδ^*}(U - S)) = \text{dr}_{ñδ^*}(U - S)$.

2.15 Definition

$\text{fr}_{ñδ^*}(S) = \text{cl}_{ñδ^*}(S) - \text{int}_{ñδ^*}(S)$ is said to be the ñδ*-frontier of S.

2.16 Theorem

For any subset S of an NITS (U, N, I), the given below are holds:

(i) $\text{cl}_{ñδ^*}(S) = \text{int}_{ñδ^*}(S) \cup \text{fr}_{ñδ^*}(S)$.

(ii) $\text{int}_{ñδ^*}(S) \cap \text{fr}_{ñδ^*}(S) = \emptyset$.

(iii) $\text{br}_{ñδ^*}(S) \subseteq \text{fr}_{ñδ^*}(S)$.

(iv) $\text{fr}_{ñδ^*}(S) = \text{cl}_{ñδ^*}(S) \cap \text{cl}_{ñδ^*}(U - S)$.

(v) $\text{fr}_{ñδ^*}(S)$ is ñδ*-closed.

(vi) $\text{fr}_{ñδ^*}(\text{fr}_{ñδ^*}(S)) \subseteq \text{fr}_{ñδ^*}(S)$.

(vii) $\text{fr}_{ñδ^*}(\text{int}_{ñδ^*}(S)) \subseteq \text{fr}_{ñδ^*}(S)$.

(viii) $\text{int}_{ñδ^*}(S) = S - \text{fr}_{ñδ^*}(S)$.

Proof

(i) $\text{int}_{ñδ^*}(S) \cup \text{fr}_{ñδ^*}(S) = (\text{int}_{ñδ^*}(S)) \cup (\text{cl}_{ñδ^*}(S) - \text{int}_{ñδ^*}(S)) = \text{cl}_{ñδ^*}(S)$.

(ii) $\text{int}_{ñδ^*}(S) \cap \text{fr}_{ñδ^*}(S) = (\text{int}_{ñδ^*}(S)) \cap (\text{cl}_{ñδ^*}(S) - \text{int}_{ñδ^*}(S)) = \emptyset$.

(iii) $\text{br}_{ñδ^*}(S) = S - \text{int}_{ñδ^*}(S) \subseteq \text{cl}_{ñδ^*}(S) - \text{int}_{ñδ^*}(S) = \text{fr}_{ñδ^*}(S)$.

(iv) $\text{fr}_{ñδ^*}(S) = \text{cl}_{ñδ^*}(S) - \text{int}_{ñδ^*}(S) = \text{cl}_{ñδ^*}(S) \cap \text{cl}_{ñδ^*}(U - S)$.

(v) $\text{cl}_{ñδ^*}(\text{fr}_{ñδ^*}(S)) = \text{cl}_{ñδ^*}(\text{cl}_{ñδ^*}(S) - \text{int}_{ñδ^*}(S)) = \text{cl}_{ñδ^*}(\text{cl}_{ñδ^*}(S) \cap (U - \text{int}_{ñδ^*}(S))) = \text{cl}_{ñδ^*}(\text{cl}_{ñδ^*}(S) \cap (\text{cl}_{ñδ^*}(U - S))) \subseteq \text{cl}_{ñδ^*}(\text{cl}_{ñδ^*}(S)) \cap \text{cl}_{ñδ^*}(\text{cl}_{ñδ^*}(U - S)) = \text{cl}_{ñδ^*}(S) \cap \text{cl}_{ñδ^*}(U - S) = \text{cl}_{ñδ^*}(S) \cap (U - \text{int}_{ñδ^*}(S)) = \text{cl}_{ñδ^*}(S) - \text{int}_{ñδ^*}(S) = \text{fr}_{ñδ^*}(S)$. Always, $\text{fr}_{ñδ^*}(S) \subseteq \text{cl}_{ñδ^*}(\text{fr}_{ñδ^*}(S))$. Therefore, $\text{cl}_{ñδ^*}(\text{fr}_{ñδ^*}(S)) = \text{fr}_{ñδ^*}(S)$. Hence $\text{fr}_{ñδ^*}(S)$ is ñδ*-closed.

(vi) $\text{fr}_{ñδ^*}(\text{fr}_{ñδ^*}(S)) = \text{cl}_{ñδ^*}(\text{fr}_{ñδ^*}(S)) - \text{int}_{ñδ^*}(\text{fr}_{ñδ^*}(S)) = \text{cl}_{ñδ^*}(\text{cl}_{ñδ^*}(S) - \text{int}_{ñδ^*}(S)) - \text{int}_{ñδ^*}(\text{cl}_{ñδ^*}(S) - \text{int}_{ñδ^*}(S)) = \text{cl}_{ñδ^*}(\text{cl}_{ñδ^*}(S) \cap (U - \text{int}_{ñδ^*}(S))) - \text{int}_{ñδ^*}(\text{cl}_{ñδ^*}(S) \cap (U - \text{int}_{ñδ^*}(S))) = (\text{cl}_{ñδ^*}(\text{cl}_{ñδ^*}(S)) \cap \text{cl}_{ñδ^*}(\text{cl}_{ñδ^*}(U - S))) - (\text{int}_{ñδ^*}(\text{cl}_{ñδ^*}(S)) \cap \text{int}_{ñδ^*}(\text{cl}_{ñδ^*}(U - S))) \subseteq (\text{cl}_{ñδ^*}(S) \cap \text{cl}_{ñδ^*}(U - S)) = \text{cl}_{ñδ^*}(S) \cap (U - \text{int}_{ñδ^*}(S)) = \text{cl}_{ñδ^*}(S) - \text{int}_{ñδ^*}(S) = \text{fr}_{ñδ^*}(S)$.

(vii) $\text{fr}_{ñδ^*}(\text{int}_{ñδ^*}(S)) = \text{cl}_{ñδ^*}(\text{int}_{ñδ^*}(S)) - \text{int}_{ñδ^*}(\text{int}_{ñδ^*}(S)) \subseteq \text{cl}_{ñδ^*}(S) - \text{int}_{ñδ^*}(S) = \text{fr}_{ñδ^*}(S)$.

(viii) $S - fr_{ñδ*}(S) = S \cap (U - fr_{ñδ*}(S)) = S \cap (U - (cl_{ñδ*}(S) - int_{ñδ*}(S))) = S \cap (U - (cl_{ñδ*}(S) \cap (U - int_{ñδ*}(S)))) = S \cap((U - cl_{ñδ*}(S))\cup (int_{ñδ*}(S)))) = \emptyset \cup int_{ñδ*}(S) = int_{ñδ*}(S)$. The given below Example 2.17 illustrates that the reverse implication of Theorem 2.16 (iii) fails in some situations.

2.17 Example

Let $U = \{g_1, g_2, g_3, g_4\}$, $X = \{g_1, g_4\} \subseteq U$, $U/R = \{\{g_2\}, \{g_4\}, \{g_1, g_3\}\}$, $N = \{U, \emptyset, \{g_4\}, \{g_1, g_3, g_4\}, \{g_1, g_3\}\}$ and the ideal $I = \{\emptyset, \{g_2\}\}$. Take $S = \{g_1, g_4\}$. Then $fr_{ñδ*}(S) = \{g_1, g_2, g_3\}$ and $br_{ñδ*}(S) = \{g_1\}$. Therefore, $br_{ñδ*}(S) \not\supseteq fr_{ñδ*}(S)$.

2.18 Definition

$ext_{ñδ*}(S) = int_{ñδ*}(U - S)$ is said to be a $ñδ*$-exterior of S.

2.19 Theorem

Let (U, N, I) be an NITS and $S \subseteq U$, the given below are holds:

(i) $ext_{ñδ*}(S)$ is $ñδ*$-open set.

(ii) $ext_{ñδ*}(S) = U - cl_{ñδ*}(S)$.

(iii) $ext_{ñδ*}(ext_{ñδ*}(S)) = int_{ñδ*}(cl_{ñδ*}(S))$.

(iv) If $S \subseteq T$, then $ext_{ñδ*}(S) \supseteq ext_{ñδ*}(T)$.

(v) $ext_{ñδ*}(S \cup T) \subseteq ext_{ñδ*}(S) \cap ext_{ñδ*}(T)$.

(vi) $ext_{ñδ*}(S \cap T) \supseteq ext_{ñδ*}(S) \cup ext_{ñδ*}(T)$.

(vii) $ext_{ñδ*}(U) = \emptyset$.

(viii) $ext_{ñδ*}(\emptyset) = U$.

(ix) $ext_{ñδ*}(S) = ext_{ñδ*}(U - ext_{ñδ*}(S))$.

(x) $int_{ñδ*}(S) \subseteq ext_{ñδ*}(ext_{ñδ*}(S))$.

Proof

(i) By Definition 2.18, the proof is clear.

(ii) $ext_{ñδ*}(S) = int_{ñδ*}(U - S) = U - cl_{ñδ*}(S)$.

(iii) $ext_{ñδ*}(ext_{ñδ*}(S)) = ext_{ñδ*}(int_{ñδ*}(U - S) = ext_{ñδ*}(U - cl_{ñδ*}(S)) = int_{ñδ*}(U - (U - cl_{ñδ*}(S))) = int_{ñδ*}(cl_{ñδ*}(S))$.

(iv) Since $S \subseteq T$, $int_{ñδ*}(U - T) \subseteq int_{ñδ*}(U - S)$. Hence, it is clear by Definition of border.

(v) $ext_{ñδ*}(S \cup T) = int_{ñδ*}(U - (S \cup T)) = int_{ñδ*}((U - S) \cap (U - T)) \subseteq int_{ñδ*}(U - S) \cap int_{ñδ*}(U - T) = ext_{ñδ*}(S) \cap ext_{ñδ*}(T)$.

(vi) $ext_{ñδ*}(S \cap T) = int_{ñδ*}(U - (S \cap T)) = int_{ñδ*}((U - S) \cap (U - T)) \supseteq int_{ñδ*}(U - S) \cup int_{ñδ*}(U - T) = ext_{ñδ*}(S) \cup ext_{ñδ*}(T)$.

(vii) The proof is obvious.

(viii) The proof is obvious.

(ix) $ext_{ñδ*}(U - ext_{ñδ*}(S)) = ext_{ñδ*}(U - ext_{ñδ*}(U - S)) = int_{ñδ*}(U - (U - int_{ñδ*}(U - S))) = int_{ñδ*}(int_{ñδ*}(U - S)) = int_{ñδ*}(U - S) = ext_{ñδ*}(S)$.

(x) $int_{ñδ*}(S) \subseteq int_{ñδ*}(cl_{ñδ*}(S)) = int_{ñδ*}(U - int_{ñδ*}(U - S)) = int_{ñδ*}(U - ext_{ñδ*}(S)) = ext_{ñδ*}(ext_{ñδ*}(S))$.

RESULTS AND DISCUSSION

In this article we explored the nano form of $δ*$-closed sets namely $ñδ*$-closed sets in nano ideal topological space. We investigated $ñδ*$-local function $S_{ñδ*}$ and the associated closure operator $cl_{ñδ*}(S)$ of a subset S of the universe. Also proved $S_{ñδ*}$ is a $ñδ*$-closed set and $int_{ñδ*}(S)$ is the format $ñδ*$-open set in S. The correlation of $int_{ñδ*}(S)$ with $cl_{ñδ*}(S)$ also deduced. Remarkably it is established that the closure operator studied here fulfills the kuratowski axioms and so the collection of $ñδ*$-open sets forms topology. $ñδ*$-derived set of S is defined as the collection of $ñδ*$-accumulation point of S and studied its important properties. Also discussed the exterior, frontier and border of the $ñδ*$-closed set and its properties.

CONCLUSIONS

Having been defined the ñδ*-closed sets in nano ideal topological space we see that this can be extended to other areas like ñδ*-interior, ñδ*-closure, ñδ*-exterior, ñδ*-frontier, ñδ*-derived set and ñδ*-border of a subset S of U in the same space. Thus the present work gives a base for further studies in this area of research. Presently we are working towards the development of this work.

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RESEARCH ARTICLE

Qualitative Phytochemical Screening of Different Solvent Extracts of *Curcuma caesia*

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ABSTRACT

Curcuma caesia Roxb, a member of the Zingiberaceae family and one of the rarest medicinal herbs, is traditionally used to cure a number of illnesses. Kali haldi is another name for it. Leucoderma, asthma, tumors, piles, bronchitis, bruising, antiparasitic, diuretic, hepatoprotective, laxative, and sedative disorders have all been treated with the herb, according to ethnobotanical usage. The extractive values of the non-aerial section (rhizome) of *Curcuma caesia* are identified in the current study. Water, methanol, acetone, hexane, and chloroform each had a percentage yield of 18.7, 10.1, 1.5, 3.4, and 3.2%, respectively. The rhizome of the plant extracts contained a range of phytoconstituents, including alkaloids, saponin, quinones, terpenoids, steroids, tannins, flavonoids, cardiac glycosides, and coumarins, according to the qualitative chemical investigations. In this article, a number of verified facts about the plant *Curcuma caesia* have been compiled in order to validate its traditional use and open the door for a source of potential treatments in the near future.

Keywords: *Curcuma caesia*, Zingiberaceae, phytoconstituent, coumarin, cardiac glycosides.

INTRODUCTION

Many pharmacologically active principles and compounds, which are often used in home remedies for a variety of ailments, are thought to be abundant in Indian medicinal plants [1]. The management of human health and disease is improved by traditional medicine and its applications, which are founded on ancient knowledge, skills, and practices

[2]. They are the best substitute for modern medicine because they have no negative side effects, rely on nature, and are inexpensive [3]. The medicinal plant products, which are derived from plant parts such stems, bark, leaves, fruits, and seeds, have been used in phytomedicine and have a particular physiological impact on the human body [4]. Plant-based herbal medicine has been thoroughly investigated by the traditional medical system, and it has been demonstrated that these remedies have significant therapeutic potential. Plants phytochemical composition is what gives them their anti-oxidant, anti-microbial, anti-pyretic, anti-inflammatory, and anti-tumor properties [5]. The important genus Curcuma Linn belongs to the Zingiberaceae family. It is comprised up of over 70 different species of rhizomatous plants, both wild and domesticated, that are spread out over Southeast Asia. Curcuma species have been employed for their therapeutic properties by Indian ethnic communities for a very long time [6].Different dialects of India have different names for *Curcuma caesia*, including Kali haldi (Hindi), Kola halodhi (Assamese), Shyrmitiong (Khasi), Nallapasupu (Telugu), Kariarishina (Kannada), Aihang (Mizo), Yaingangamuba or yaimu (Manipuri), Kala haldi (Bengali), Yakanekeliti (Adi tribe), Homen (Khamti tribe), and black turmeric in English signifying its bluish-black rhizome [7]. Black zedoary or black turmeric, also known as *Curcuma caesia* Roxb., is a species of the Curcuma plant that is distinguished by rhizomes that are deep bluish black or grayish black in color, have a strong aroma, and have a fiery, bitter flavor [8]. Its leaves exhibit an all-over, intense reddish-violet blotch. Native to Northeast India, the plant species is also found in Java and Myanmar. In the Andhra Pradesh districts of East Godavari, West Godavari, and Khammam, black turmeric is also uncommon. Due to its alleged medicinal qualities, the kali haldi rhizomes are of great commercial value [9]. The rhizomes are used to cure a variety of ailments, including gonorrheal discharges, hemorrhoids, leprosy, asthma, cancer, epilepsy, fever, wounds, vomiting, and menstrual abnormalities [10]. The paste is applied on bruises, contusions, and rheumatic ailments in Manipur [11]. To treat diarrhea, the Adi tribes of Arunachal Pradesh prepare a decoction of fresh rhizome. The Lohit area of Khamti tribe administered a paste produced from fresh rhizomes in cases of snake and scorpion bites [12]. In Madhya Pradesh, the plant is revered as being exceedingly auspicious and is thought to grant its owner a never-ending supply of food and cereal. Rhizomes of the plant have a pleasant scent. The interior of the rhizome is bluish-black and emits a characteristic, pleasant smell because it contains essential oil [13].

MATERIALS AND METHODS

Collection of Plant Material
The entire plant material used in the current study was collected in the Indian state of Manipur Bishnupur District between the months of March and April 2023.

Processing of Plant Materials
The gathered rhizome were washed, dried in the shade until all the water had drained, and then cleaned. The dried plant material (rhizome) that had been shed was then removed and processed into a coarse powder. The powdered samples were stored neatly in an airtight glass container with appropriate labeling for examination.

Preparation of Plant Extracts
Different solvents, including methanol, hexane, chloroform, acetone, and water were used to create the plant's rhizome extracts. 500ml of each solvent were used to extract 100g of the dried and powdered plant material (rhizome). For 24 hours or until the solvent in the extractor's siphon tube turns colorless, the extraction process is carried out. Through the use of a rotating vacuum evaporator, all of the extracts were concentrated and dried. Dried extract was stored in a 4°C refrigerator for use in a phytochemical examination later on.

Percentage Yield of Extract (%)
The percentage of extraction yield (%) was calculated by dividing the weight of the crude extract that was obtained after extraction by the weight of the plant powder that was weighed prior to extraction and multiplying the result by 100. The resultant extract was weighed, and each solvent's extractive value was determined as follows:

$$\text{Percentage of yield (\%)} = \frac{\text{weight of extract}}{\text{weight of dry plant powder}} \times 100$$

Screening of Phytochemicals

Phytochemical analysis was done in accordance with standard procedures to identify alkaloids, saponins, quinones, tannins, terpenoids, flavonoids, phenol, phytosterol, coumarin, amino acid, carbohydrate and cardiac glycosides. Using the recommended techniques, the extracts were examined for the presence of bioactive components.

Alkaloids Test

A dull white precipitate formed after adding 2 ml of Mayer's reagent to 1 ml of the extract revealed the presence of alkaloids.

Saponin Test

A test tube containing crude extract was filled with five milliliters of distilled water, the mixture was quickly agitated, and then a few drops of olive oil were added. Saponin is present when a consistent foam is produced.

Quinones Test

1 ml of the extract was mixed with 1 ml of concentrated H_2SO_4, and when the reddish colour formed, quinones were present.

Terpenoids Test

2 ml of extract was mixed with 1 ml of chloroform, then a few drops of strong H_2SO_4 were added. The formation of a reddish-brown precipitate instantly revealed the presence of terpenoids.

Carbohydrates Test

A few drops of plant extract were added to 5 ml of Benedict's reagent, heated for 2 minutes, and then cooled. Red precipitate formation shows the presence of carbohydrates.

Steroids Test

2 ml of chloroform were combined with 0.5 ml of plant extract in the test tube. Carefully adding 3ml of concentrated H_2SO_4 from the test tube wall created a lower layer. The presence of steroid was revealed by the reddish-brown color that occasionally appeared at the interface.

Tannins Test

A precipitate formed after a few ml of potassium dichromate were added to the plant extract, confirming the presence of tannins and phenolics.

Amino acid and protein

2 ml of filtrate was treated with 2–5 drops of ninhydrin solution and placed in a boiling water bath for 1–2 minutes. Formation of purple colour indicates the presence of amino acid and protein.

Flavonoids Test

After adding the stock solution (1 ml) to the test tube, a couple of drops of diluted NaOH solution were added. Bright yellow coloration changed in the test tube. It turned colorless after being added a few drops of diluted HCl, proving the presence of flavonoids.

Cardiac Glycosides Test

A drop of ferric chloride and concentrated H_2SO_4 were added to the plant extract in a test tube along with a few ml of glacial acetic acid. The presence of cardiac glycosides is indicated by the color green.

Coumarins Test

1 mL of extract and 1 mL of 10% NaOH were added. It is known that coumarins are present when a yellow color forms.

RESULTS AND DISCUSSION

Extractive Values of Different Solvents

Table 1 provides information about the extractive value of the solvent *Curcuma caesia.* Water extract clearly had the highest value, followed by methanol extract, while acetone extract had the lowest value. The extraction of bioactive substances should be effective when using solvents with high extractive properties. The majority of active compounds are polar in nature, hence polar solvents are anticipated to have high extractive properties.

Qualitative Phytochemical Screening

The results of the qualitative phytochemical screening performed on the solvent-extracts of *Curcuma caesia* are displayed in Table 2. During extraction, methanol, acetone, chloroform, hexane, and water are used as solvents. Nine of the eleven phytochemicals that were examined for presence in different solvent extracts were found. According to the results of this study, there are phytochemicals that are believed to be the active chemical components of pharmaceuticals. Significant medicinal phytochemicals like coumarins, alkaloids, saponins, quinones, terpenoids, steroids, tannins, flavonoids, cardiac glycosides, and saponins were present in the rhizome of *Curcuma caesia*. This shows that the rhizomes contain a variety of possible phytochemicals. There were no proteins, amino acids, or carbohydrates in the current investigation. The presence of tannins, alkaloids, saponins, quinones, terpenoids, and steroids was discovered in a water extract from the rhizome. Methanol and acetone, on the other hand, contained cardiac glycosides, coumarin, tannins, steroids, flavonoids, alkaloids, and terpenoids.

Numerous phytochemicals have been found to engage in a variety of activities that may help prevent disease. Alkaloids aid in the prevention of chronic diseases. Saponins have antimicrobial properties and lower cholesterol levels. Steroids and terpenoids have analgesic effects on central nervous system functions [16]. These phytochemicals suggest that the solvent extracts of *Curcuma caesia* have some physiological and therapeutic activity; however, as can be observed from the data collected in the aforementioned tables [16,17], this differs from solvent to solvent and from plant to plant. The cholesterol-lowering effects of steroids are thought to be caused by steroids, whereas saponins are the only substances that can precipitate and coagulate red blood cells [18]. Steroids also help to regulate the immune system's reaction [19]. Tannins are incredibly stern in nature. They are known for hastening the healing of sores and swollen mucous membranes. Flavonoids, which are potent water-soluble antioxidants and free radical scavengers that lessen oxidative cell damage [20,21]. It also helps manage the oxidative stress brought on by diabetes. It has been found that terpenoids can be useful in the treatment and prevention of a variety of diseases, including cancer. Terpenoids also possess anti-allergenic, anti-spasmodic, anti-hyperglycemic, anti-inflammatory, and immunomodulatory properties [22,23].

CONCLUSION

It is clear from the current investigation phytochemical analysis that it provided valuable information about the various phytoconstituents found in the plant. This information will be helpful to future researchers as they choose which extract to use for additional research isolating the active ingredient. It also provided insight into the various phytochemicals that have been discovered to have a variety of activities. Alkaloids, flavonoids, terpenoids, tannins, etc. are examples of secondary metabolites that are found in plant extracts. The phytochemical study of *Curcuma caesia* is significant and of economic importance to both research institutions and pharmaceutical corporations for the production of new medications for the treatment of various ailments.

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Table 1: Percentage yields of rhizome extract in different solvent of *Curcuma caesia*

Sl.No.	Solvent	Weight of extract	% of Yield
1.	Aqueous	18.7	18.7
2.	Chloroform	3.2	3.2
3.	Hexane	3.4	3.4

4.	Methanol	10.1	10.1
5.	Acetone	1.5	1.5

Table 2:Phytochemical constituents present in different extracts of *Curcuma caesia*

Sl. No.	Name of phytochemical compounds	Rhizome extracts of *Curcuma caesia*				
		Methanol	Acetone	Hexane	Chloroform	Water
1.	Alkaloids	+	+	-	-	+
2.	Saponins	-	-	-	+	+
3.	Quinones	+	+	-	+	+
4.	Terpenoids	+	+	+	-	+
5.	Carbohydrates	-	+	-	-	-
6.	Steroids	+	+	+	+	+
7.	Tannins	+	+	-	+	+
8.	Amino acid and protein	-	-	-	-	-
9.	Flavonoids	+	-	-	+	-
10.	Cardiac Glycosides	+	+	+	-	-
11.	Coumarins	+	+	-	-	-

"+" present, "-" absent
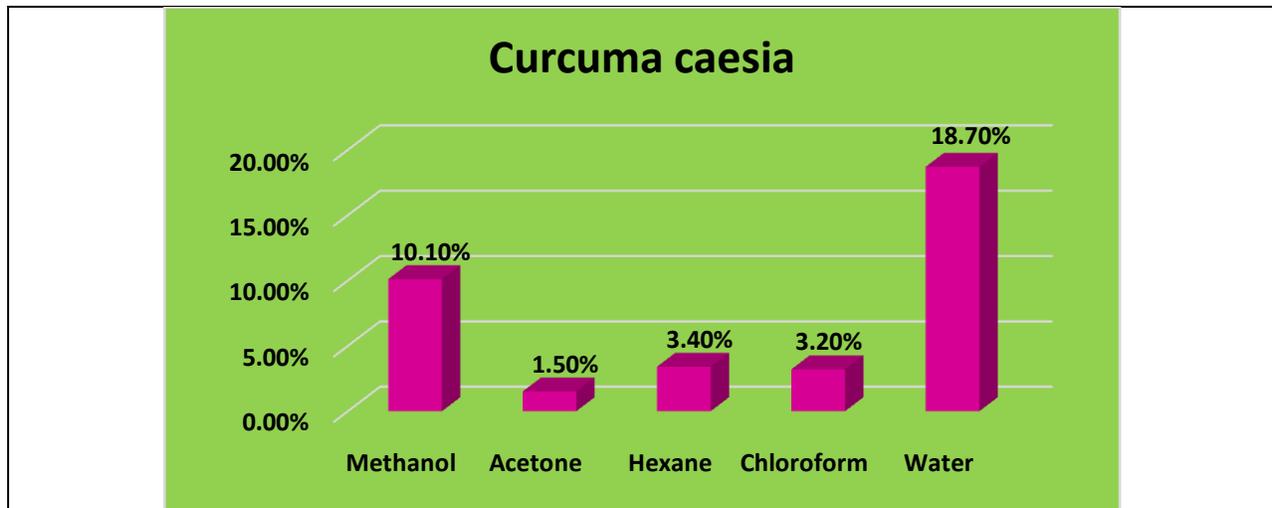
Fig1: Percentage yield of *Curcuma caesia*

Methanol extract   **Acetone extract**

Fig 2: Different solvent extracts of *Curcuma caesia*

RESEARCH ARTICLE
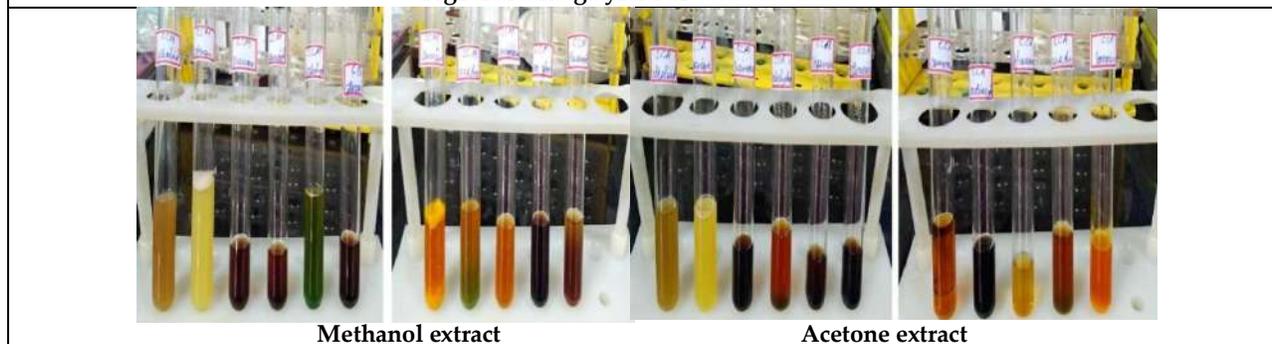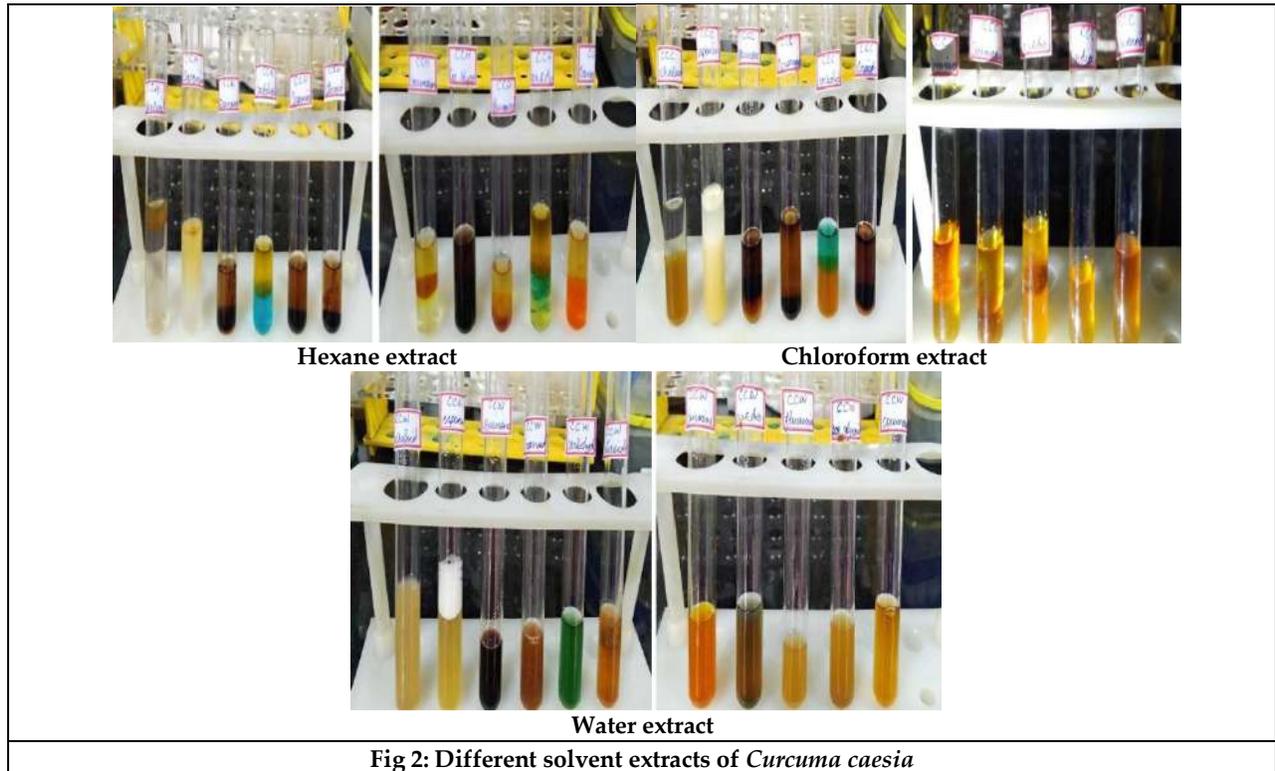
A Comprehensive Analysis on Early Forecasting and Pest Monitoring in Crops

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ABSTRACT

Agriculture is a necessary means of subsistence. In India, this industry offers significant chances for villages to work on a vast scale. A poll revealed that approximately 70% of the Indian population relies on agriculture. Agriculture in this region consists of various crop compositions that vary according to weather conditions. However, most Indian farmers lack technical information, such as which crop is best suited to their acreage. Numerous diverse diseases adversely impair agricultural yield, resulting in a loss of profit. This article discusses pest illnesses in detail and their effect on the crop's present productivity. Additionally, it displays survey results generated using various image recognition methods. It is critical to seek and develop more strategies for identifying pest diseases before they cause significant agricultural production losses. Currently, the only way to control insect illness is to use pesticides. However, this process has a detrimental effect on human health, either directly or indirectly. Early detection strategies may reduce the requirement for pesticide spraying. The image detection technology demonstrates its efficacy as a measuring tool in the battle against infestation. This technology enables more efficient crop management and production by providing optimal crop protection. Additionally, these systems decrease human error and labor by including the capability of autonomous monitoring across wide areas.

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INTRODUCTION

Agriculture is critical to the evolution of human civilization. Agriculture research is focused on enhancing production and food quality. Environmental and biological elements affect the quality and quantity of agricultural produce. Pests and plant diseases are the primary biological parameters. In agriculture, the primary issues are diseases and insect pests. These need a meticulous diagnosis and prompt treatment to avoid significant crop losses. Observation with the naked eye is the most often used approach for detecting pests and diagnosing plant diseases. This requires constant monitoring. However, this is impractical for vast farms. Additionally, it is not an accurate, costly, or time-consuming way of integrated pest management (IPM) intended to control pests with the least environmental effect. IPM consists of three steps: detection, identification, and implementation of proper management. Pests are a significant source of agricultural loss [1]. Insects may be especially destructive because they graze on plants, impair photosynthesis, and act as carriers for various deadly illnesses [2]. Several chemical and biological pest control approaches [3], but regular monitoring of the whole property is often necessary to maximize their efficiency. Monitoring is often carried out passively by personnel as they do their regular tasks. The disadvantage of this strategy is that significant harm may have already been done by the time an infestation is discovered. Early detection of pests needs a more methodical approach, which is especially important on large farms. Without a doubt, traps are the most widely utilized form of systematic pest monitoring [4, 5].

When utilized properly, this kind of equipment may efficiently sample insect populations over a vast area. However, without automation, traps must still be placed and collected manually. Infestation evaluation requires visual examination, which adds subjectivity and may result in a biased appraisal of the problem [5, 6]. Thus, regardless of whether traps are employed or not, systems capable of promptly, accurately, and autonomously assessing the health of pests are required. Significant effort has been made to enhance pest detection and classification. While direct detection is the most prevalent method, numerous other ways focus on identifying associated damage rather than pests [7–9]. Numerous early studies sought to locate and identify insects by analyzing the sounds they emitted. However, interest in this technique seems to have declined during the last decade [10]. Nowadays, the majority of research accomplishes this goal via the use of digital photos [10, 11]. While aerial photographs taken by unmanned aerial vehicles (UAV) are increasingly being studied [12, 13], they often lack the resolution required to identify minute species, and plant canopies may hinder detection. As a consequence, proximal images remain dominating. While researchers are investigating multispectral [14, 15], hyperspectral [16, 17], thermal [18], and X-ray [10] sensors, RGB (Red-Green-Blue) sensors continue to dominate due to their low cost, portability, and versatility [19]. Researchers may use image processing tools to solve complex problems. It is an indication of how rapidly digital technology has advanced in agricultural research. Automated detection of insect pests is a potential solution for image analysis. Numerous papers enhance the implementation methodologies by assessing insect populations in rice fields using an automated detection system. Rice production (both in terms of quality and quantity) rises when agricultural technicians use suitable pest management measures and count pests from collected specimens. Establishing a highly efficient monitoring system becomes straightforward when using an automated system. Cameras are a great monitoring and detection technique for rice infestations.

BACKGROUND STUDY

Agarwal et al. [11] created a CNN model consisting of three convolutional layers, three maximum pooling layers, and two fully connected layers. Each layer had unique filters that allowed for the detection of nine separate tomato leaf diseases. The experimental results demonstrated that the proposed model had an average accuracy of 91.2 percent on the test set, outperforming VGG16, Mobile Net, and Inception. Hu et al. [12] sought to address the dearth of methods for diagnosing _ne-grained tomato diseases. We employed five distinct tomato-damaged leaves in their

early and late stages as research objects. The authors proposed a unique convolutional neural network model called ARNet that is based on the principles of attention and residuals. In classification, ARNet outperformed known models such as VGG16, with an average recognition accuracy of 88.2 percent. Guo et al. [13] developed a multi-receptive field recognition model based on Alex Net (Multi-Scale Alex Net) by eliminating the Alex Net network's local response normalization layer, modifying the network's fully connected layers, and extracting features using a multi-scale convolution kernel. The study's components include the Plant Village dataset and seven distinct varieties of diseased tomato leaves that I collected personally. The model reduced the original Alex Net's memory requirements by 95.4 percent while raising the average accuracy of tomato leaf diseases and disease stages to 92.7 percent. Fan et al. [14] enhanced the Faster R-CNN model's convolutional layer with a batch standardization layer, incorporated a central cost function to generate a mixed cost function, and improved the training model using a stochastic gradient descent technique. They investigated nine separate maize leaf diseases, each with a unique field history. When utilized in the same experimental scenario, the new technique boosted average accuracy by 8.86 percent. In comparison to the SSD technique, the time required to identify a single image was decreased by 0.139 s; the average accuracy was enhanced by 4.25 percent; and the time required to detect a single image was reduced by 0.018 s. Zhang et al. [15] addressed the problem of an Alex Net model with an excessive number of parameters and a single feature scale by using expansion convolution and global pooling. They introduced an Alex Net-based extended convolutional neural network with global pooling (GPD CNN). Following the expansion, a dataset of six common cucumber leaf diseases obtained in the field achieved 95.18 percent accuracy.

RELATED STUDY TO PEST DETECTION

Current Methods Used by the Crop Technicians in Sampling Insect Pests in the Paddy Fields

At the moment, insect pest populations and damage to rice are often dispersed haphazardly and eventually clumped [16]. That is why farmers used a sampling strategy to attain this goal; they gathered, numbered, and examined a small percentage of the insect population. It develops patterns in the population of an organism. The sampling technique is employed primarily for two purposes: research and pest control decision-making, both of which often require significant time, effort, and price. There are no standard sample methodologies; instead, sampling is carried out using a number of techniques and devices, depending on the job at hand. Among them is the effective use of pest surveillance and monitoring systems, which results in more precise intervention timing and reduced production costs. According to Carino, Kenmore, and Dyck [17], the following sample methods and technologies may be used to make pest control decisions: The light trap, which collects samples of varying sizes, is useful for comparing seasonal and annual insect catches, but catches are subject to changes in insect behavior and do not capture flying insects; the sweep net (collecting insects with a fishnet) is a simple, cost-effective method for sampling arthropods that remain in the canoe. Arthropods are rapidly identified and counted in the field upon tapping; visual counting and data recording may also be accomplished in the field but are subject to human error and are very labor-intensive; Additionally, the sticky trap is economical; it monitors insect movement and colonization but excludes non-flying insects. The yellow pan trap is similarly cost-effective; it records insect movement and facilitates sample sorting and counting; however, the attraction is based on color stimulation and does not catch flying insects.

Feature Extraction and Image Processing

Image processing is the analysis and manipulation of graphical images collected from a variety of sources, including photographs and motion pictures. The three basic stages of image processing are as follows: transforming gathered images to binary values that a computer can process; augmenting and compressing the image; and last, displaying or publishing the processed image. Image processing is used in satellite weather mapping, machine vision, and computer-based pattern recognition. Phinyomark, Limsakul, and Phukpattaranont [18] pioneered a novel feature extraction approach for Electromyography data by representing interference with white Gaussian noise. For robust feature extraction, we supplied two distinct mean and median frequencies. Alsmadin, Omar, Noa, and Almarashdeh [19] showed utilizing robust feature extraction, a system capable of identifying discrete patterns of interest in images. The approach was used as a classifier to classify and categorize fish into deadly and non-poisonous families.

Real-Life Application of Image Processing in the Fields of Agricultural Research

Numerous attempts have been undertaken to build automated insect identification systems that are image-based. Samantha and Ghosh's study [20] examines eight major insect pests utilizing data from tea farms in India's North Bengal area. The authors collect and reduce features using correlation-based approaches then classify using an incremental back propagation neural network methodology. Do, Harp, and Norris [21] created a non-specialist-friendly automated pattern recognition approach for identifying arachnids and other arthropods. The researchers recommend early pest detection in greenhouse crops in order to limit pesticide use. The purpose of this approach is to identify pests on plant organs such as leaves. Their project aims to build an innovative decision support system for in-situ early pest detection by analyzing and interpreting video data from several cameras. They utilized the apriori algorithm to classify whiteflies and aphids in their research and used a broad approach to developing a system that is easily extensible to different sorts of progressors. Al-Saqer [22] developed a neural network-based approach for detecting pecan weevils. They were able to identify the pecan weevil by feeding visual descriptions into a neural network. The authors took photographs of pecan weevils and other insects that they discovered in paddy fields. They converted the pictures to binary and scaled them to 114134 pixels after obtaining them. They used a variety of image processing techniques, including Regional Properties and Zernike Moments, to analyze the data. Zhu and Zhang [23] presented a report in which they described their development of a novel method for recognizing insects. They used integrated region matching and the dual-tree complex wavelet transform to match pictures. The acquired lepidopteran insects' photographs were shrunk to 248200 pixels and filtered using the mean shift method. Using the color feature and a k-mean approach, the processed image is divided into sections. They used pixel-wise segmentation to classify pixels into sections based on their color properties

COMPARATIVE ANALYSIS OF SURVEY
DISCUSSION

The primary challenge is to provide reliable detection results for illumination changes. Changes in lighting may occur due to changing weather conditions or the earth's rotation. Due to variations in the weather, visual characteristics such as color, intensity, and contrast will fluctuate. There are many plant species and several pests. Thus, the plant database has several big picture bases (image databases). Image categorization using high-speed image processing is a complicated task.

CONCLUSION

Several image processing techniques are discussed in this article, including feature extraction and automatic detection. The survey illustrates the effectiveness and ease with which presently available options may be used. Numerous ways for acquiring knowledge about background modeling for pest identification are discussed here, including picture filtering, median filtering for noise reduction, image extraction, and detection through scanning. This article discusses some promising studies that exhibit improved methodology and tools for fully automated pest identification, including extraction and detection. Viruses, illnesses, animal pests, and weeds all wreak havoc on agricultural output worldwide. Pest group attacks result in both relative and absolute losses. In high-production tropics and subtropics, conditions support fast crop growth. However, in certain areas, owing to favorable weather conditions, the bug may inflict severe damage to the crop. As a result, crop protection strategies are required to prevent pest proliferation. Additionally, farmers should be familiar with such practices. The study's future possibilities might include developing more sophisticated image processing systems that are both accurate and efficient. Additionally, it may be developed to provide an effective object extraction identification system.

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Table 1 Evaluation of various authors views

Author Name	Methodology	Limitations
Agnihotri, V. [1]	ML with Raspberry Pi.	Could not identify all of the pests using thermal vision.
Chen, C.-J., et al. [2]	Deep-learning YOLOv3.	Training samples are limited through data preprocessing. Accuracy is 90%.
Li, R.et al. [5]	Data augmentation with CNN.	Applications are limited to specific pests and cannot be used widely. Accuracy is 81.4%.
Nagar, H., & Sharma, R. S. [7]	Wavelet transformation and Oriented FAST and rotated BRIEF (ORB).	Limited pest scouting expertise with the owners of large fields. Accuracy is 91.89%.
Tetila, E. C. et al. [10]	Simple linear iterative clustering (SLIC) method and CNN.	Cannot detect lesions on leaves, old aphid exoskeletons, and areas of complex lighting conditions. Accuracy is 94.89%.
Yong AI.et al. [24]	Inception-ResNet-v2 model and CNN.	Data set is minimal, it should be extended. Accuracy is 86.1%.
V Suresh.,et al. [25]	CNN - Convolutional Neural Network.	For real time environment images, it produce low accuracy.(For Apple - 70.8% , Black rot - 82.6%)
YanfenLia.,et al. [26]	Using CNN &GoogLeNet.	It consumes more power and time to identify the pests. Accuracy is 98.91%.
Mustafa Kareem Hadi[28]	MATLAB image processing toolbox.	There is a critical case of noise that can affect the accuracy of the insect counting and detection. Accuracy is 85.2%.
Hiroki TANI[27]	Deep learning with CNN.	Diagnosis performance failed while analyzing multiple images. Accuracy is 95.5%.
R. K. Samanta[20]	Data Mining.	Missing data, a common problem of data mining has been addressed. Accuracy is 96.5%.
Pruthvi P. Patel[8]	Deep Learning with Convolutional Neural Networks.	CNN needs large datasets and sometimes takes much longer to train. Accuracy is 98.67%.

Figure 1: Different pests in crops

RESEARCH ARTICLE

Estimation of Wear Volume of Piston Ring along the Circumference using 3D Modeling

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ABSTRACT

Piston Ring of an I C Engine experiences wear as is usually experienced by all the components of an I C Engine. But the contribution of friction in a piston ring assembly is the maximum. Most wear models, have quantified wear of a piston ring in terms of total wear volume (Archard's wear equation), total weight loss or depth of the wear scar with an underlined assumption that wear is uniform along the circumference. This research work presents the comparison of results of wear calculation of the top piston ring of an IC Engine by measuring piston ring profile at 9 different angular sections, constituting 8 sectors of piston ring. Piston ring profile was measured over axial width of the worn-out piston ring at 13 different locations along the axial direction for each of the 9 sections. Volume loss for each of the 8 sectors is calculated by comparing piston ring profile of worn-out piston ring with profile of new piston ring of same type. The results have been compared with the software results (calculations done by CREO). The wear volume loss calculated by the analytical method has been compared with the results of CREO. The pattern of the wear volume loss in both the cases is the almost similar. It is observed that the wear volume loss is different for different sectors.

Keywords: Piston ring, Wear, Piston ring profile, Wear volume.

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INTRODUCTION

A piston ring experiences wear due to the asperities contact between piston ring and the cylinder liner. Wear of piston ring has been considered as uniform along the circumference by many researchers in past. Pike W.C and Spillman D.T [1] have measured total wear rate at different torques of motored engines. T. H. C. Childs and F. Sabbagh [2] have simulated the real engine conditions by   pin-on-disk tests and have calculated that total wear volume loss in a top piston ring. P. C. Nautiyal et al [3],have given a theoretical model for piston ring wear rate in terms of energy of absorption, the material properties, and the operating conditions. Priest et al.[4] have developed a numerical model that predicts wear of piston ring at one particular point on the circumference of the piston ring and these results has been compared with the experimental results. Simon Tung & Y Huang[5] have developed a three body wear abrasion model for the piston ring. Combining the effects of surface roughness and oil degradation, the total wear volume loss due to the abrasive wear has been investigated. There has been no mention of variation in wear of the piston ring in the research. Truhan J.J &Blau P.J [6] have developed a test method to evaluate wear behaviour of candidate piston ring and cylinder liner materials for heavy duty diesel engine applications with realistic lubricants. The authors have measured the wear scar geometry at a particular crank angle and calculated the total wear volume loss rather than the variation. Bulsara M.A et al [7] have measured wear profile along a circumference of the piston ring of different makes and have compared it with a new piston ring. The authors have mentioned about the variation of wear volume along the circumference of the top piston ring. Smith E [9] showed through design of experiments (DOE) that the oil film thickness gives an inference of total wear of the piston ring. Zheng M et al [10] have quantified total wear using Archard's wear equation. Mishra P.C [11] has given a contact conjunction of a piston ring-pack and rough out-of-round cylinder is modelled to analyze the sources of the total wear rate. Research done up till now has emphasized on total wear volume or wear depth at a particular region of the piston ring. This research focuses on the variation of the wear volume along the circumference of the top piston ring.

Experimental Setup
Volumetric wear of piston ring was calculated by comparing volume of worn piston ring with volume of new (unworn). Volume of worn piston ring was calculated by measuring piston ring axial profile at 9 different sections along the circumference and calculating the volume by interpolation between two successive sections. Volume of new (unworn) piston ring was calculated based on the ring face profile of new piston ring of same make. A worn-out piston ring from Hero Honda Splendor has been selected for the study as the motorbike is the bestselling motorbikes with consistent sales of 2 lakh units in India every year. The specifications of the engine are:
Engine capacity: 97.2 cc, 4 stroke, single cylinder, OHC
Bore Diameter: 50 mm
Stroke Length: 49.5 mm
Piston Ring outer diameter: 50 mm
Piston ring inner diameter: 47 mm
Piston Ring Number: 100, Usha Make
Piston Ring axial thickness: 1mm

Figure 1
a)Schematic diagram for measuring profile of piston ring. b) The schematic diagram of the fixture for measuring the profile of the piston ring. c) Photograph of the measurement setup. A fixture was designed and manufactured for the purpose of measurement of the piston ring profile as in figure 1(a).The fixture consists of shaft, collar, clamp-plate and spacer rings. The shaft was machined and ground between centres on cylindrical grinding machine. Outer diameter and inner diameter of the collar was also machined and ground between centres on cylindrical grinding machine to have tight fit between shaft and collar. A shoulder is provided on the collar so that the piston ring can rest against the shoulder when clamped with clamp-plate with required number of spacer rings. The collar is

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assembled with shaft with tight fit assembly. Piston ring under test is mounted on the collar such that it rests on the shoulder, along with spacer rings. Both are fastened as one unit, together with clamp-plate screwed to the collar as shown in figure 1(b). The fixture along with piston ring is mounted between centres on centre lathe. Two dial gauges are used 'Dial Gauge A' and 'Dial Gauge B' for the measurement of piston ring axial profile. 'Dial Gauge A' has least count of 0.001 mm and that of 'Dial Gauge B' is 0.01 mm. Piston ring is mounted on the collar such that the inner diameter of piston ring rests on the collar to ensure same datum for every measurement. Stylus of 'Dial Gauge A' is mounted on specimen piston ring as shown in figure 1(a) such that it can measure the variation in piston ring profile in radial direction.

Measuring the ring profile along the axial direction of the piston ring
It was decided to measure piston axial ring profile at 9 angular sections at angle 10°, 45°,180 90°, 135°, 180°, 225°, 270°, 315°, 350°, as shown in figure 2. This way the piston ring is divided into 8 sectors S1 to S8. The angular positions were marked on the piston ring before beginning of measurements. To measure the axial profile of piston ring at any angular section, measurement begins with one of the faces of the ring, 'Ring Face-1' shown in figure 3 and continues up to 'Ring Face-2' .Stylus of 'Dial Gauge A' is fixed at point 1 (on piston ring) and scale of dial gauge is adjusted such that 'zero' mark of scale coincides with the pointer. Base of the 'Dial Gauge A' is mounted on the lathe bed so that the dial gauge A is stationary. Base of 'Dial Gauge B' is also mounted on the lathe bed but the stylus of the dial gauge is adjusted such that it senses the movement of carriage. Now, the carriage is manually moved along axial direction incrementing 0.0091 mm at a time and corresponding radial deflection of 'Dial gauge-A' due to variation of ring profile is recorded. The measurements were taken at 13 points along the axial width of piston ring on each section. The piston ring was rotated to next section, after 13 reading were taken at a given section, to maintain the same datum (see figure 1) with respect to dial gauge. The datum for measurement is the outer diameter of the collar as shown in Figure 1.The axial profile readings are taken at 9 sections viz. 10^0, 45^0, 90^0, 135^0, 180^0, 225^0, 270^0, 315^0 and 350^0 angles along the circumference of the piston ring (see figure 2).

Experiment and Measurement
The research work focuses on calculating degree of wear at different sectors along the circumference of the top piston ring. Wear of piston ring can be quantified as difference in volumes of a new piston ring and worn-out piston ring by measuring the piston ring profile.

Calculation of wear volume of the piston ring along the circumference
In order to calculate wear volume along the circumference, the piston was divided into eight sectors S1, S2, S3,S4,S5,S6,S7, S8 as shown in figure 2 by way of 9 sections. Consider sector 1 which is enclosed by section-1 and section-2. Each section on new piston ring as shown in figure 4(a) is represented by M_i (where i=1 to 9) sections. Thirteen measurements of ring profile were taken along axial direction on section-1. These measurements are represented by $M_{1,1}$, $M_{1,2}$, ..., $M_{1,13}$ ($M_{i,j}$, where i = 1 and j = 1 to 13). Similarly, points $M_{2,1}$, $M_{2,2}$, ..., $M_{2,13}$ ($N_{i,j}$, where i = 2 and j = 1 to 13) can be identified on section 2. Analogous points $H_{1,1}$, $H_{1,2}$, ..., $H_{1,13}$ (H_{ij}, where i = 1 and j = 1 to 13) on section 1 and points $H_{2,1}$, $H_{2,2}$, ..., $H_{2,13}$ (H_{ij}, where i = 2 and j = 1 to 13) can be identified on section 2 of worn out piston ring as shown in figure 4(b).To calculate the volume for any sector of worn out ring, it is assumed that profile between points $M_{i,j}$ on section 'i' varies linearly up to corresponding point to $N_{i+1,j}$ on the subsequent section 'i+1'. Wear of the piston ring is calculated by finding the difference between the volume enclosed by curved profile of new piston ring L1-N1-O1-L2-N2-O2-L1, indicated as W_1 (see figure 4a). Volume enclosed by the curved profile J1-K1-I1-J2-K2-I2 indicated as W_2 (see figure 4b) is the volume left over after wear of the piston ring. The process is repeated for each of the 8 sectors. The process of calculating volume for worn out ring is elucidated in the subsequent text. Volumetric wear can be calculated by determining the difference between W_1 and W_2 for each sector.

Volume calculation for new piston ring (V_N)
Methodology adopted to determine volume enclosed between two sections of the new piston ring is illustrated in figure 5 and figure 6. Profile of new piston ring is measured at 13 equi-distant divisions along axial width of piston ring by dividing each section into 12 equal parts as shown in figure 5. Volume of each of the 12 parts is calculated

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separately. For example, consider two divisions say 10 and 11 between section 1 and 2 respectively, they are $P_{1,10}$ & $P_{1,11}$ on section-1 and correspondingly $P_{2,10}$ & $P_{2,11}$ on section-2 (highlighted), on the axial width of the piston ring. Volume enclosed by profile of piston ring between two points on section-1 and two corresponding points on section-2 is calculated as the volume of the solid '$P_{1,10}$-$P_{1,11}$-$P_{2,11}$ -$P_{2,10}$- $P_{1,10}$-D-C-B-A-D' as shown in figure 9 (enlarged view is shown in figure 6). The volumes of the 12 axial parts are calculated as above and the volumes are summated to get the total volume $V_{N,1}$ of sector-1. The exercise is repeated for remaining 7 sectors. Total volume of piston ring profile for new piston ring is sum of all eight volumes. ($V_N = V_{N,1} + V_{N,1} + ... + V_{N,8}$) between two sections (figure 3, figure 4) on the circumference of the new piston ring

Volume calculation of wear volume for worn out piston ring (V_W)

Axial profile of worn out piston ring was measured at 13 points in axial direction, at each of 9 sections and the results are tabulated in table 1. The readings are average of three measurements taken by the dial gauge. The volume of piston ring profile in a sector enclosed by two sections of worn out piston ring is illustrated as. Each sector is divided into 12 parts in axial direction by measurements of profile at 13 axial divisions on the profile at each section(figure 7(a)). For example, profile between two axial positions 10 and 11 (highlighted) on each section 1 and 2 is shown in figure 7(b). The volume enclosed by points '$P_{1,10}$-$P_{1,11}$-$P_{2,11}$ -$P_{2,10}$- $P_{1,10}$-D-C-B-A-D' is divided further into two parts as shown in figure 7(c). The volume of each half solid is calculated separately by approximating the volume as trapezoids as shown in figure 7(c). Volume of solid represented by points '$P_{1,10}$-$P_{1,11}$-$P_{2,11}$-$P_{2,10}$-$P_{1,10}$-D-C-B-A-D' is calculated by summing up the volume of 10 trapezoids. Likewise volume has been calculated for all the 12 axial parts on the profiles between two sections. Volume of sector 1 represented as $V_{W,i}$ is calculated by taking sum of volume of each of the 12 parts. Total volume enclosed by worn profile in a sector bound by two sections is calculated by summing the volumes of 12 such parts. The volume calculations have been done by a code generated in MATLAB. Summation of volume of all 8 sectors $V_{W,1}$ to $V_{W,8}$ gives the total volume of worn piston ring W_2.

RESULTS AND DISCUSSIONS

Wear Volume Analysis

Wear volume at each sector for worn out piston ring is calculated by subtracting volume of each sector of worn piston ring $V_{W,i}$ from corresponding volume $V_{N,i}$ of New piston ring for a sector i.Volumetric wear in each sector can be represented as percentage of volume of new piston ring of the respective sector. Percentage wear of a sector P_i = ($V_{N,i}$ - $V_{W,i}$)/ $V_{N,i}$ Volumetric wear in each sector as percentage of volume of new piston ring of the respective sector is graphically represented below in fig. 8: It can be observed from table-2 along with Fig.8 that the wear of piston ring is not uniform throughout the circumference. The wear is more near the end gap (10° to 45° and 315° to 350°). Wear is least at about 180° from end gap. As wear is caused due to friction which is caused due to lack of lubricant, it can be inferred that oil film thickness formed along the circumference is not uniform. It is likely that portion of ring near end gap undergo boundary lubrication for most of the part of stroke whereas the remaining portion of piston ring experiences hydrodynamic lubrication for most of the part of stroke.

Validation by software

The volume loss due to wear has been a validated by a modelling software creo 3.0. The volume between section 1 and section 2 is calculated by the software and the modelling is shown in fig 9. The volume of a between section 1 and section 2 of a new piston ring is calculated by the software and the modelling is shown in Fig 10.

CONCLUSION

The volume loss due to wear near the end gap (sector 1 and sector 8) is more as compared to the other sectors of the piston ring as illustrated. A non uniform wear pattern has been observed by the above study (see figure 8) for longer period of stroke. This leads us to infer that the piston ring experiences boundary lubrication near the end gap of the

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piston ring till 45^0. It experiences mixed lubrication regime from 45^0 to 180^0 and from 135^0 to 180^0 from the centre of the gap it experiences hydrodynamic lubrication. The behaviour is symmetrical about the end gap. The piston ring experiences boundary lubrication from 350^0 (near the end gap) till 315^0, mixed lubrication from 315^0 to 180^0 and hydrodynamic lubrication from 180^0 to 225^0(opposite the gap of the piston ring). The software results show a similar behaviour of the wear volume loss pattern as the analytical calculations, along the circumference of the piston ring. It can be inferred from both the results that the piston ring experiences hydrodynamic lubrication from 180^0-225^0 from the centre of the end gap of the piston ring.

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Table 1: Measurement of profile in micrometers at the 13 points along the axial direction.

Pos. No.	10^0 (Sec 1)	45^0 (Sec2)	90^0 (Sec 3)	135^0 (Sec 4)	180^0 (Sec 5)	225^0 (Sec 6)	270^0 (Sec 7)	315^0 (Sec 8)	350^0 (Sec 9)
1	0	0	0	0	0	0	0	0	0
2	6	10	11	15	6	9	7	16	6
3	11	15	25	25	25	21	20	29	15
4	23	26	40	56	45	40	40	45	35
5	29	52	65	69	79	74	70	78	45
6	34	62	90	90	106	107	112	103	37
7	22	69	95	115	125	120	122	114	26
8	12	60	70	90	110	90	108	105	17
9	8	35	40	75	90	70	72	74	10
10	5	20	25	30	65	40	46	55	6
11	0	10	12	14	40	17	12	29	0
12	0	0	0	0	6	6	5	6	0
13	0	0	0	0	0	0	0	0	0

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Table 2: Sector-wise Percentage wear of worn piston ring.

Sector No.	Bounds of sector (Deg.)	Sector size (Deg.)	Volume of sector of new piston ring $V_{N,i}$ (mm³)	Volume of sector of worn piston ring $V_{W,i}$ (mm³)	Wear Volume of worn piston ring $W_i = V_{N,i} - V_{W,i}$ (mm³)	Sector-wise Percentage wear (P_i) (%)
1	10-45	35	1.32	0.484	0.836	63.33
2	45-90	45	1.69	0.747	0.943	55.80
3	90-135	45	1.69	0.904	0.786	46.51
5	135-180	45	1.69	1.027	0.663	39.23
6	180-225	45	1.69	1.052	0.638	37.75
7	225-270	45	1.69	1.049	0.641	37.93
8	270-315	45	1.69	1.033	0.657	38.88
9	315-350	35	1.32	0.504	0.816	61.82

Table 3: Sector-wise Percentage wear of worn piston ring.

Sector No.	Bounds of sector (Deg.)	Sector size (Deg.)	Volume of sector of new piston ring $V_{N,i}$ (mm³)	Volume of sector of worn piston ring $V_{w,i}$ (mm³)	Wear Volume of worn piston ring $W_i = V_{N,i} - V_{W,i}$ (mm³)	Sector-wise Percentage wear (P_i) (%)
1	10-45	35	1.42	0.3025	1.1175	78.6
2	45-90	45	1.83	0.5885	1.2415	67.8
3	90-135	45	1.83	0.7429	1.0871	59.4
4	135-180	45	1.83	0.8761	0.9539	52.1
5	180-225	45	1.83	0.9151	0.9149	50
6	225-270	45	1.83	0.8692	0.9608	52.5
7	270-315	45	1.83	0.8762	0.9538	52.1
8	315-350	35	1.42	0.5420	0.878	61.8

Figure 1:a):Schematic diagram for measuring profile of piston ring.	**Figure 1:b) The schematic diagram of the fixture for measuring the profile of the piston ring.**

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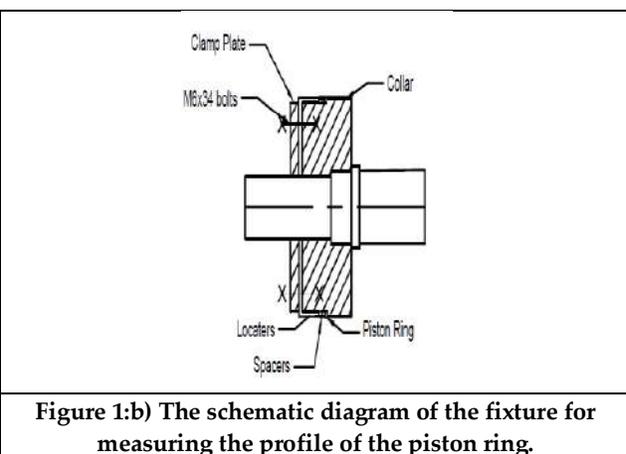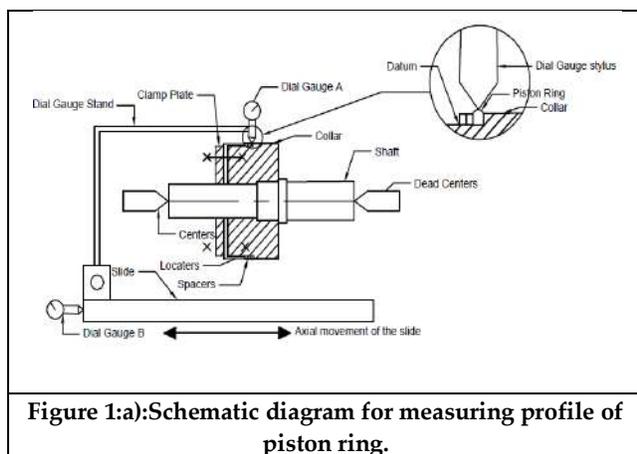
Figure 1: c) Photograph of the measurement setup.	**Figure 2: Sections at which the axial profile measurement is taken. Piston ring profile along axial width was measured with the help of dial gauge at 13 points.**
Figure 3: Thirteen Axial positions for measurement of piston ring profile	**Figure 4: a) Axial profile of new piston ring.**
Figure 4 b) Axial profile of worn out piston ring.	**Figure 5 a) Axial profile of a new piston ring between a sector**
Figure 5 b) Highlighted Solid	**Figure 6: Axial profile of worn out piston ring at different sections.**
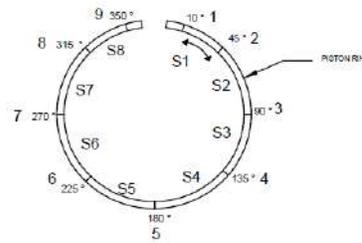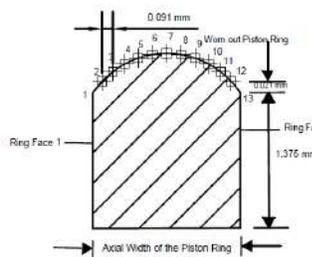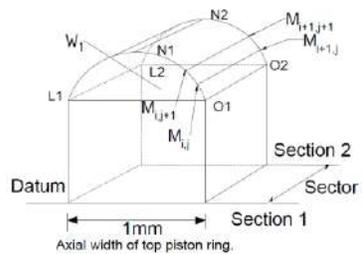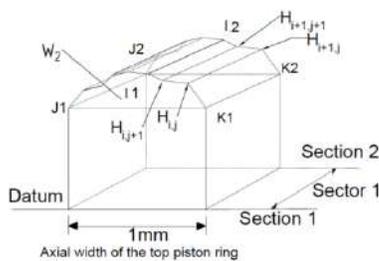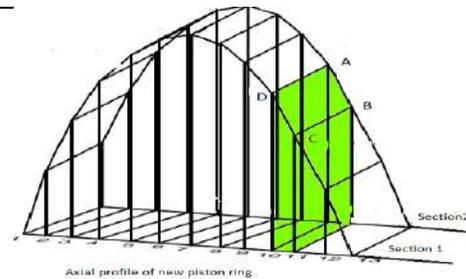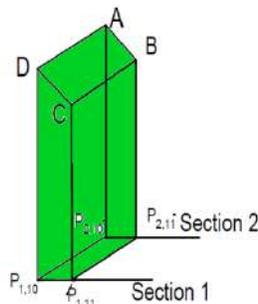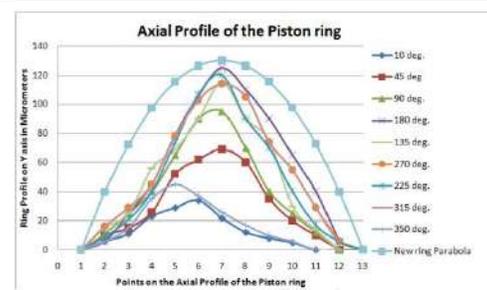
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Figure 7:a)Axial profile of a worn out piston ring between a sector	**Figure 7:b) Highlighted Solid**

Figure 7 c) Approximated solid for volume calculations.	**Figure 8: Wear volume as percentage volume of material in respective sectors of new piston ring.**

Figure.9 The volume of a between section 1 and section 2 of a new piston ring is calculated by the software and the modeling is shown in Fig 10.	**Figure.10. The output of the software**

Figure 11: Comparison of analytical method of calculation of percentage wear with the software results of piston ring along its circumference

RESEARCH ARTICLE

Root Square Mean Labeling of Some Disconnected Graphs

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ABSTRACT

A graph G with p points and q lines is known as root square mean graph if it is possible to value the points $y \, \epsilon \, V$ with different lables $f(y)$ from $1,2,\ldots,q+1$ so that when every line $e = sr$ is valued with $f(e = sr) = \left\lfloor \sqrt{\frac{f(s)^2+f(r)^2}{2}} \right\rfloor \, or \, \left\lceil \sqrt{\frac{f(s)^2+f(r)^2}{2}} \right\rceil$, then the resulting line values are different. f is known as root square mean labeling of G. During this paper, we prove that disconnected graphs such as $(C_n@P_m) \cup L_g, (C_n@P_m) \cup TL_g, (C_n@P_m) \cup T_g, (C_n@P_m) \cup D(T_g), (C_n@P_m) \cup Q_g, (C_n@P_m) \cup D(Q_g)$ are root square mean graphs.

Keywords: Root square mean labeling, Ladder, Triangular snake, Quadrilateral snake, Dragon.

INTRODUCTION

S.S.Sandhya.et.al [8] introduced this root square mean labeling of graphs and they also proved that some disconnected graphs are root square mean graphs in [9]. Meena. S and Mani. R [3,4,5,6,7] investigated this labeling for some cycle related graphs.

Definition 1.1

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A graph G with p points and q lines is known as root square mean graph if it is possible to value the points $y \epsilon V$ with different lables $f(y)$ from $1,2,...,q+1$ so that when every line $e = sr$ is valued with $f(e = sr) = \left\lfloor \sqrt{\frac{f(s)^2 + f(r)^2}{2}} \right\rfloor$ or $\left\lceil \sqrt{\frac{f(s)^2 + f(r)^2}{2}} \right\rceil$, then the resulting line values are different. f is known as root square mean labeling of G.

Definition 1.2   "
A triangular ladder TL_m is a graph got from ladder L_m by connecting the lines s_i and $s'_{i+1}, 1 \le i \le m-1$, where s_i and $s'_i, 1 \le i \le m$ are the points of L_m such that $s_1 s_2 ... s_m$ and $s'_1 s'_2 ... s'_m$ are two paths of length m in the graph L_m.

Definition 1.3
A triangular snake T_m is got from a path $s_1 s_2 ... s_m$ by connecting s_i and s_{i+1} to a new points s'_i for $1 \le i \le m-1$.

Definition 1.4
A double triangular snake $D(T_m)$ consists of two triangular snakes that have a common path.

Definition 1.5
A quadrilateral snake Q_m is got from a path $s_1 s_2 ... s_m$ by connecting s_i and s_{i+1} to a new points s'_i and s''_i for $1 \le i \le m-1$ respectively and then connects s'_i and s''_i.

Definition 1.6
A Double Quadrilateral snake $D(Q_m)$ consists of two quadrilateral snakes that have a common path.

Definition 1.7
The union of two graphs $P_1 = (V_1, E_1)$ and $P_2 = (V_2, E_2)$ is a graph $P = P_1 \cup P_2$ with point set $V = V_1 \cup V_2$ and the line set $E = E_1 \cup E_2$.

Definition 1.8
A dragon is formed by attaching the end node of a path to a cycle. It is denoted by $C_n @ P_m$."

Notations
Here $[h]$ is the least integer greater than or equal to h and $[h]$ is greatest integer less than or equal to h.

Main Results
The root square mean labeling of some disconnected graphs were presented in this paper.

Theorem 2.1
$(C_n @ P_m) \cup L_h$ is a root square mean graph.

Proof
Let $G = (C_n @ P_m) \cup L_h$
Let $a_1 a_2 ... a_n$ be the points of cycles C_n in G and let $a'_1 a'_2 ... a'_m$ be the points of the path P_m attached at cycle C_n with $a_n = a'_1$.
  Let $c_1 c_2 ... c_h$ and $d_1 d_2 ... d_h$ be the points of ladder L_h.
  Let $V(G) = \{a'_i /1 \le i \le m\} \cup \{a_i / 1 \le i \le n\} \cup \{c_i, d_i / 1 \le i \le h\}$
  $E(G) = \{a_i a_{i+1} / 1 \le i \le n-1\} \cup \{a'_i a'_{i+1} / 1 \le i \le m-1\}$
    $\cup \{c_i c_{i+1} / 1 \le i \le h-1\} \cup \{d_i d_{i+1} / 1 \le i \le h-1\} \cup \{d_i c_i / 1 \le i \le h\}$.
Define a mapping $f: V(G) \to \{1,2,...,m+n+3h-2\}$ by
  $f(a_i) = i$ for $1 \le i \le n$

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$$f(a_i^{'}) = n + i - 1 \qquad \text{for } 2 \le i \le m$$
$$f(c_i) = n + m + 3i - 2 \qquad \text{for } 1 \le i \le h$$
$$f(d_i) = n + m + 2i - 2 \qquad \text{for } 1 \le i \le 2$$
$$f(d_i) = n + m + 3i - 4 \qquad \text{for } 3 \le i \le h$$

Then the line values are different. Hence f is a root square mean labeling of G.

Theorem 2.2

$(C_n @ P_m) \cup TL_h$ is a root square mean graph.

Proof

"Let $G = (C_n @ P_m) \cup TL_h$

Let $a_1 a_2 \dots a_n$ be the points of cycles C_n in G and let $a_1^{'} a_2^{'} \dots a_m^{'}$ be the points of the path P_m attached at cycle C_n with $a_n = a_1^{'}$.

Let $c_1 c_2 \dots c_h$ and $d_1 d_2 \dots d_h$ be the points of triangular ladder TL_m.

Let $V(G) = \{a_i^{'}/1 \le i \le m\} \cup \{a_i/1 \le i \le n\} \cup \{c_i, d_i/1 \le i \le h\}$

$E(G) = \{a_i a_{i+1}/1 \le i \le n-1\} \cup \{a_i^{'} a_{i+1}^{'}/1 \le i \le m-1\}$
$\cup \{c_i c_{i+1}/1 \le i \le h-1\} \cup \{d_i d_{i+1}/1 \le i \le h-1\} \cup \{c_i d_i/1 \le i \le h\}$
$\cup \{c_i d_{i+1}/1 \le i \le h-1\}$.

Define a mapping $f: V(G) \to \{1, 2, \dots, m + n + 4h - 3\}$ by

$$f(a_i) = i \qquad \text{for } 1 \le i \le n$$
$$f(a_i^{'}) = n + i - 1 \qquad \text{for } 2 \le i \le m$$
$$f(c_i) = n + m + 4i - 3 \qquad \text{for } 1 \le i \le h$$
$$f(d_i) = n + m + 3i - 3 \qquad \text{for } 1 \le i \le 2$$
$$f(d_i) = n + m + 4i - 5 \qquad \text{for } 3 \le i \le h$$

Then the line values are different. Hence f is a root square mean labeling of G.

Theorem 2.3

$(C_n @ P_m) \cup T_h$ is a root square mean graph.

Proof

Let $G = (C_n @ P_m) \cup T_h$

Let $a_1 a_2 \dots a_n$ be the points of cycles C_n in G and let $a_1^{'} a_2^{'} \dots a_m^{'}$ be the points of the path P_m attached at cycle C_n with $a_n = a_1^{'}$.

Let $c_1 c_2 \dots c_h$ be the path P_h. Let T_h be the triangular snake got from P_h by connecting c_i and c_{i+1} to a new point $d_i, 1 \le i \le h-1$.

Let $V(G) = \{a_i/1 \le i \le n\} \cup \{a_i^{'}/1 \le i \le m\} \cup \{c_i, d_i/1 \le i \le h\}$

$E(G) = \{a_i a_{i+1}/1 \le i \le n-1\} \cup \{a_i^{'} a_{i+1}^{'}/1 \le i \le m-1\}$
$\cup \{c_i c_{i+1}/1 \le i \le h-1\} \cup \{d_i c_{i+1}/1 \le i \le h-1\} \cup \{c_i d_i/1 \le i \le h-1\}$.

Define a mapping $f: V(G) \to \{1, 2, \dots, m + n + 3h - 3\}$ by

$$f(a_i) = i \qquad \text{for } 1 \le i \le n$$
$$f(a_i^{'}) = n + i - 1 \qquad \text{for } 2 \le i \le m$$
$$f(c_i) = n + m + 2i - 1 \qquad \text{for } 1 \le i \le 2$$
$$f(c_i) = n + m + 3i - 3 \qquad \text{for } 3 \le i \le h$$
$$f(d_i) = n + m + 4i - 4 \qquad \text{for } 1 \le i \le 2$$
$$f(d_i) = n + m + 3i - 2 \qquad \text{for } 3 \le i \le h-1$$

Then the line values are different. Hence f is a root square mean labeling of G.

Theorem 2.4

$(C_n @ P_m) \cup D(T_h)$ is a root square mean graph.

Proof

Let $G = (C_n @ P_m) \cup D(T_h)$

Let $a_1 a_2 \ldots a_n$ be the points of cycles C_n in G and let $a_1' a_2' \ldots a_m'$ be the points of the path P_m attached at cycle C_n with $a_n = a_1'$.

Let $c_1 c_2 \ldots c_h$ be the path P_h. Let double triangular snake $D(T_h)$ got by joining c_i and c_{i+1} to two new adjacent points d_i and d_i' $1 \le i \le h - 1$.

Let $V(G) = \{a_i / 1 \le i \le n\} \cup \{a_i' / 1 \le i \le m\} \cup \{c_i, d_i, d_i' / 1 \le i \le h\}$

$E(G) = \{a_i a_{i+1} / 1 \le i \le n - 1\} \cup \{a_i' a_{i+1}' / 1 \le i \le m - 1\}$

$\qquad \cup \{c_i c_{i+1} / 1 \le i \le h - 1\} \cup \{c_i d_i, d_i c_{i+1} / 1 \le i \le h - 1\}$

$\qquad \cup \{c_i d_i', d_i' c_{i+1} / 1 \le i \le h - 1\}.$

Define a mapping $f : V(G) \to \{1, 2, \ldots, m + n + 5h - 5\}$ by

$f(a_i) = i$	for $1 \le i \le n$
$f(a_i') = n + i - 1$	for $2 \le i \le m$
$f(c_i) = n + m + 5i - 5$	for $1 \le i \le h$
$f(d_i) = n + m + 5i - 4$	for $1 \le i \le h - 1$
$f(d_i') = n + m + 5i - 3$	for $1 \le i \le h - 1$

Then the line values are differet. Hence f is a root square mean labeling of G.

Theorem 2.5

$(C_n @ P_m) \cup Q_h$ is a root square mean graph.

Proof

Let $G = (C_n @ P_m) \cup Q_h$

Let $a_1 a_2 \ldots a_n$ be the points of cycles C_n in G and let $a_1' a_2' \ldots a_m'$ be the points of the path P_m attached at cycle C_n with $a_n = a_1'$.

Let $c_1 c_2 \ldots c_h$ be the path P_h. Let Q_h be the qadrilateral snake got by connecting c_i and c_{i+1} to two new adjacent points d_i and d_i' $1 \le i \le h - 1$ respectively.

Let $V(G) = \{a_i / 1 \le i \le n\} \cup \{a_i' / 1 \le i \le m\} \cup \{c_i, d_i, d_i' / 1 \le i \le h\}$

$E(G) = \{a_i a_{i+1} / 1 \le i \le n - 1\} \cup \{a_i' a_{i+1}' / 1 \le i \le m - 1\}$

$\cup \{c_i c_{i+1} / 1 \le i \le h - 1\} \cup \{c_i d_i, d_i d_i', d_i' c_{i+1} / 1 \le i \le h - 1\}.$

Define a mapping $f : V(G) \to \{1, 2, \ldots, m + n + 4h - 4\}$ by

$f(a_i) = i$	for $1 \le i \le n$
$f(a_i') = n + i - 1$	for $2 \le i \le m$
$f(c_i) = n + m + 2i$	for $1 \le i \le 2$
$f(c_i) = n + m + 4i - 4$	for $3 \le i \le h$
$f(d_i) = n + m + 5i - 5$	for $1 \le i \le 2$
$f(d_i) = n + m + 4i - 3$	for $3 \le i \le h - 1$
$f(d_i') = n + m + 5i - 4$	for $1 \le i \le 2$
$f(d_i') = n + m + 4i - 2$	for $3 \le i \le h - 1$

Then the line values are different. Hence f is a root square mean labeling of G.

Theorem 2.6

$(C_n @ P_m) \cup D(Q_h)$ is a root square mean graph.

Proof

Let $G = (C_n @ P_m) \cup D(Q_h)$

Let $a_1 a_2 \ldots a_n$ be the points of cycles C_n in G and let $a_1' a_2' \ldots a_m'$ be the points of the path P_m attached at cycle C_n with $a_n = a_1'$.

Let $c_1 c_2 \ldots c_h$ be the path P_h. Let $c_i, d_i, d_i', g_i, g_i'$ be the points of double quadrilateral snake $D(Q_h)$.

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Let $V(G) = \{a_i/1 \le i \le n\} \cup \{a_i'/1 \le i \le m\} \cup \{c_i, d_i, d_i', g_i, g_i'/1 \le i \le h\}$

$E(G) = \{a_i a_{i+1}/1 \le i \le n-1\} \cup \{a_i' a_{i+1}'/1 \le i \le m-1\}$

$\qquad \cup \{c_i c_{i+1}/1 \le i \le h-1\} \cup \{c_i d_i, d_i d_i', d_i' c_{i+1}/1 \le i \le h-1\}$

$\qquad \cup \{c_i g_i, g_i g_i', g_i' c_{i+1}/1 \le i \le h-1\}.$

Define a mapping $f: V(G) \to \{1, 2, \ldots, m+n+7h-7\}$ by

$f(a_i) = i$	for $1 \le i \le n$
$f(a_i') = n+i-1$	for $2 \le i \le m$
$f(c_i) = n+m+7i-7$	for $1 \le i \le h$
$f(d_i) = n+m+7i-6$	for $1 \le i \le h-1$
$f(d_i') = n+m+7i-5$	for $1 \le i \le h-1$
$f(g_i) = n+m+7i-4$	for $1 \le i \le h-1$
$f(g_i') = n+m+7i-3$	for $1 \le i \le h-1$

Then the line values are different. Hence f is a root square mean labeling of G."

CONCLUSION

It is very interesting to find whether a graph admits root square mean labeling or not. We present six new results on root square mean labeling of some disconnected graphs.

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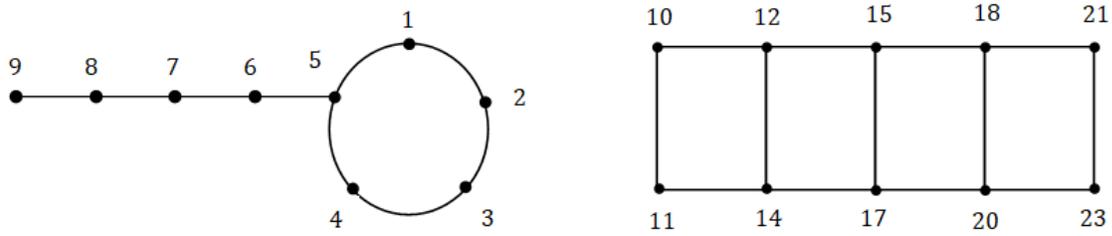
Figure 1:rsml of $(C_5@P_5) \cup L_5$
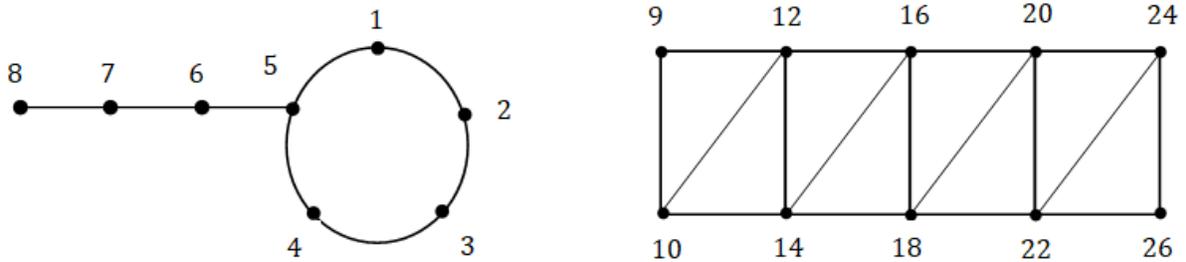
Figure 2: rsml of $(C_5@P_4) \cup L_5$
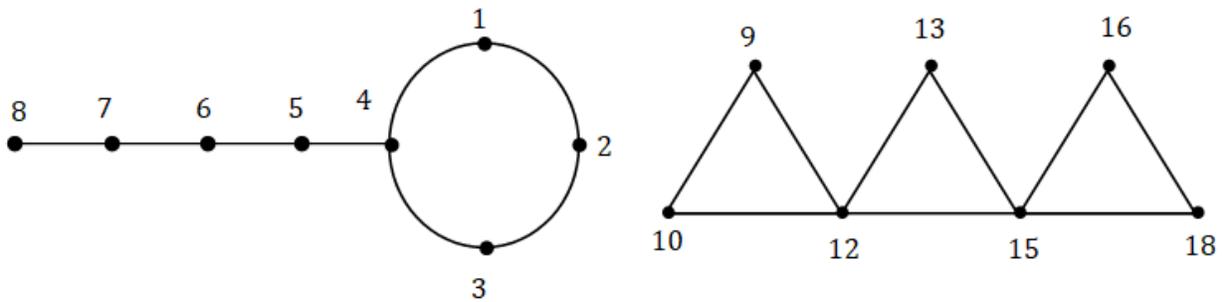
Figure 3:rsml of $(C_4@P_5) \cup T_4$
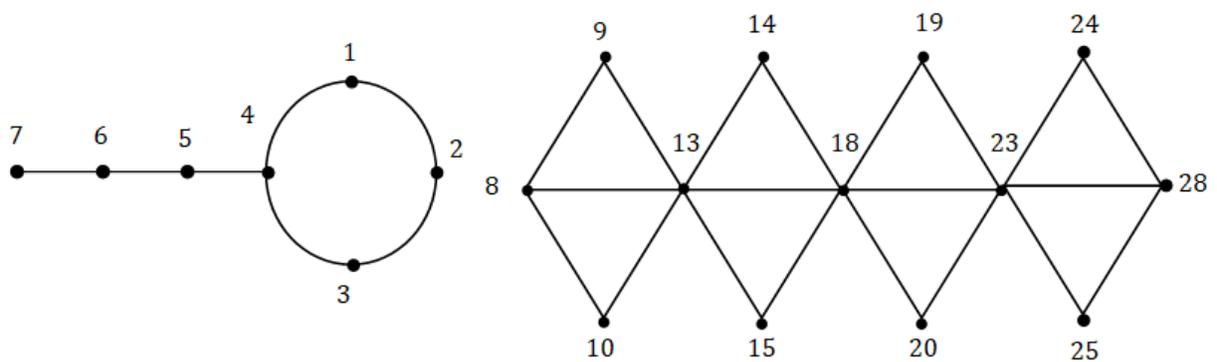
Figure 4:rsml of $(C_4@P_4) \cup D(T_5)$
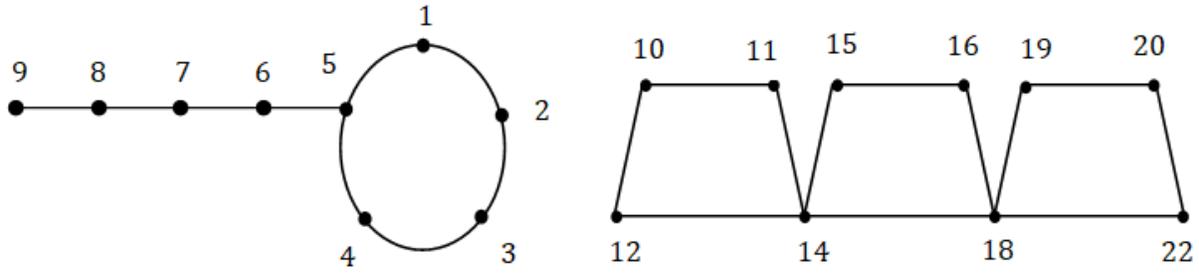
Figure 5:rsml of $(C_5@P_5) \cup Q_4$
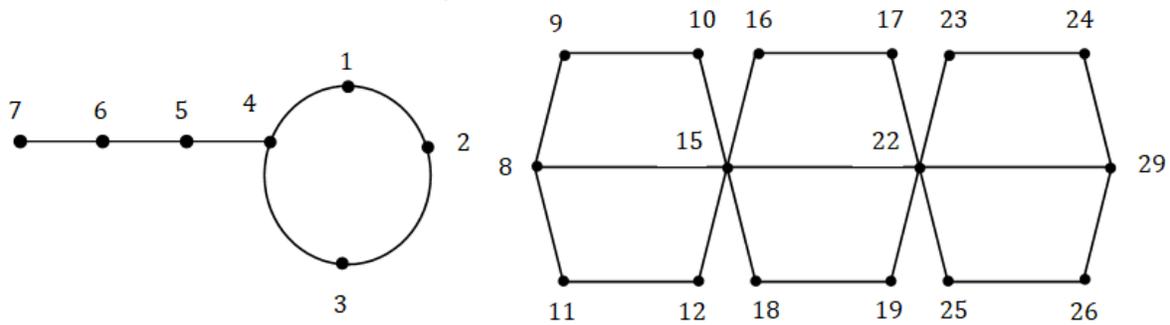
Figure 6: rsml of $(C_4@P_4) \cup D(Q_4)$

RESEARCH ARTICLE

Bio- Kinetic Study on up Flow Anaerobic Sludge Blanket Reactor for the Treatment of Waste Stream

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ABSTRACT

Anaerobic treatment of domestic wastewater is recently gained worldwide attention due to its effectiveness, low cost and low energy requirements. In this study, wastewater from textile industry was selected for the anaerobic treatment with UASB reactor. Generally, the UASB reactor is better removal efficiency for pollutants such as chemical oxygen Demand (BOD), Biological Oxygen Demand (BOD), Total Suspended Solids (TSS), Volatile Suspended Solids (VSS) and Hydrogen – ion Concentration. Further studies are required for the optimization of Biogas generation. UASB reactors effectively reduced the TDS from 4500 mg/lit to 2750 mg/lit. Its removal efficiency is 48.61%. Our Project comprised of environmental friendly waste water purification processing single stage set upper formed gave efficiency. The percentage of removal is 77.43%. COD level also decreased from 1300 mg/lit to 250 mg/lit and the removal efficiency is 80.77 mg/lit.

Keywords: Anaerobic Process, BOD, COD, UASB Reactor.

INTRODUCTION

Anaerobic process is an attractive technology for waste water treatment. The high costs of aeration and sludge handling associated with aerobic sewage treatment are dramatically lower as no oxygen is need and production of

sludge is 3 – 20 times lower. However, its use is usually limited to high strength industrial waste water with soluble substrates. Domestic waste water has typically low concentration of COD, resulting in relatively small methane production that is insufficient to heat the reactor to more favorable mesospheric temperatures. The UASB Reactor An up flow anaerobic sludge blanket reactor is basically a tank that has a sludge bed in which organic material dissolved in the wastewater is degraded, and as a consequence of this digestion, biogas is produced. Wastewater enters at the bottom of the reactor. At the top, biogas is collected and the effluent of treated water leaves at the upper part of the reactor, above the sludge bed, a blanket zone is formed where some particles of biomass are suspended.

REVIEW OF THE LITERATURE

In this chapter, literature pertaining to anaerobic treatment of organic wastewater in the production of various industries such as textile, dairy, sugar, distillery, etc., under various heads are critically reviewed, and their salient features are discussed. Application of UASB reactor, containing mixed population of bacteria , helps in bacterial immobilization of bio film on a support medium in the reactor which overcomes the problem of biomass washout. The wastewater characteristics, kinetics, and mathematical modeling facilitate better understanding and evaluation of the performance of the reactor.

EXPERIMENTAL METHODOLOGY
In the present study an experimental model of up flow anaerobic sludge blanket reactor was constructed to conduct an experiment for simulated the waste stream of textile industry to evaluate the treatment efficiency under varying experimental conditions.

EXPERIMENTAL SETUP OF UASB REACTOR
The present research work is to be carried out to evaluate the performance of Up Flow Anaerobic Sludge Blanket (UASB) reactor for the removal of textile wastewater. The size of the Up Flow Anaerobic Sludge Blanket (UASB) reactor was height 70cm, dia 9cm, packed bed 35 cm, packing material PVC, and working volume of the reactor was 3 liters. A proper construction of the blanket allowed wastewater to flow through the sludge bed from bottom up.

RESULT AND DISCUSSIONS

INITIAL CHARACTERISATION
The raw wastewater and treated wastewater are tested for their physical and chemical characteristics. Results are given below. Waste water discharges from the textile dyeing units degrade the water quality of both the surface and subsurface levels of the surrounding areas. Untreated textile dyeing effluents released from industries on open land and receiving streams increase the concentration of pollutants in the environment.

Initial Characterization of untreated sample
This causes damage to crops, humans, and the aquatic environment. Physicochemical treatment by their toxic by-products and expensiveness got away from the treatment of textile dyeing industries effluent.

Final Characterization of untreated sample
The biological treatment process of its cost-effectiveness and harmless by-products play a vital role in the treatment of textile dyeing industries effluent though the biodegradability of the textile dye effluent is below 0.5.

DISCUSSIONS

The higher TDS of the real textile dye waste water exceeds the permissible Indian effluent standards of 2100 mg/L for the disposal of the inland surface sources. The high pH which exceeds the permissible limit of Indian effluent disposal standards of 5.5-9.0 by IS-10500. The highly coloured characteristic of the textile ye waste water affects the transparency and the permissible limit of the colour is 5 in Hazen units as per the Indian standards.

CONCLUSIONS

Our Project comprised of environmental friendly waste water purification processing single stage setup performed gave efficiency. UASB reactors effectively reduced the TDS from 4500 mg/lit to 2750 mg/lit. Its removal efficiency is 48.61%. BOD and COD are important parameters of wastewater and their values indicate the organic pollution concentration. In this treatment BOD is removed effectively with the initial value of 257 mg/lit to the final value of 58 mg/lit. The percentage of removal is 77.43%. COD level also decreased from 1300 mg/lit to 250 mg/lit and the removal efficiency is 80.77 mg/lit. Its low operating power cost makes it worthwhile to consider. If power failure occurs, then process that not suffer, as it was already anaerobic in nature. Earlier study suggests that the UASB reactor is effective when it is used for treatment of low strength waste water. The sulphate removal ranges from 545 mg/lit to 300 mg/lit having the efficiency of 46.41%. The removal chloride ranges from 765 mg/lit to 365 mg/lit. The percentage of removal is 52.29%. The effective removal of phosphate in this treatment varies from 0.186 mg/lit to 0.02 mg/lit. The efficiency is 89.24%. There is an effective removal of oil which varies from 0.416 mg/lit to 0.05 mg/lit. The removal percentage is 87.98%. The pH value varies from 12.32 to 7.9 and the efficiency is35.87%. The total amount of biogas recovered during the whole project was 0.13 m^3 by the water displacement method. However in our project it is evidence that UASB reactors can also be used for treating the highest strength waste water such as textile industry waste water.

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PHYSICAL FEATURES AND PROCESS PARAMETERS OFEXPERIMENTAL MODELS

S. No.	Parameters	Dimensions
1	Overall volume	**3.0 L**
2	Working volume	**3.3 L**
3	Height	**75 cm**
4	Dia	**11 cm**
5	Packed bed	**38 cm**
6	Packing material	**PVC**

Initial Characterization of untreated sample

Analytical Parameters	Sample
Ph	12.3
TPmg/L	35.86
Colour (OD@600nm)	1.8
TDS mg/L	4500
Chlorides mg/L	765
Sulphates mg/L	545
TKN mg/L	61.25
BOD_5mg/L	257
COD mg/L	1300

Final Characterization of untreated sample

Analytical Parameters	Sample
pH	7.9
TPmg/L	25
Colour(OD@600nm)	1.3
TDS mg/L	2750
Chlorides mg/L	365
Sulphates mg/L	300
TKN mg/L	31.25
BOD_5 mg/L	58
COD mg/L	250

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Figure 1.1 UPFLOW ANAEROBIC SLUDGE BLANKET	**Fig. 1.2 Comparison of Initial and Final pH value**
Fig. 1.3 Comparison of Initial and Final TP (mg/lit)	**Fig. 1.4 Comparison of Initial and Final Colour (mg/lit)**
Fig. 1. 5 Comparison of Initial and Final TDS (mg/lit)	**Fig. 1.6 Comparison of Initial and Final Chloride (mg/lit)**

Fig. 1.7 Comparison of Initial and Final Sulphate (mg/lit)

Fig. 1.8 Comparison of Initial and Final TKN (mg/lit)

Fig. 1.9 Comparison of Initial and Final BOD (mg/lit)

Fig. 1.10 Comparison of Initial and Final COD (mg/lit)

RESEARCH ARTICLE

In vitro and *In-silico* Study of the Plant Extract of *Bixa orellana* L. with the Evaluation of It's Antibacterial and Antioxidant Properties

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ABSTRACT

The aim of this study was to determine the *in vitro* antibacterial activity of the chloroform extract of *Bixa orellana* L. leaves against some pathogenic bacterial strains viz. *S. aureus* and *P. aeruginosa* by disc diffusion assay method. The zone of inhibition produced by chloroform extracts of the plant comparing with standard antibiotics discs showed moderately significant antibacterial activity. MIC was calculated. Quantitative estimation of total phenol content also has been done using Folin- Ciocalteu method in which Gallic acid was used as standard. Also antioxidant study has been done with peroxide method. Herbal extract gel has been formulated with the evaluation of its physicochemical properties. The molecular docking of the reported phyto chemicals with the enzyme was studied using biovia discovery studio. The strength of the interaction was evaluated with the help of HDOCK server. Lowest docking score gives an idea about ligand receptor binding process.

Keywords: Lipstick Plant, HDOCK, In-silico, Herbal extract, docking.

INTRODUCTION

Bixa orellana L. from the Bixaceae family, which accumulates several carotenoid derivatives, terpenoids and flavonoids in the seeds and leaves [1]. The medicinal uses of annatto seeds include the treatment of diabetes, skin infections, burns, fever, measles,gonorrhoea, diarrhoea and asthma [2]. In addition to their antimicrobial properties,

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the polyphenol content of annatto leaf extracts has shown other biological properties including antioxidant activity [3, 4]. However very few reports have been seen involving antibacterial activity of chloroform extract from the leaves of *Bixa orellana* L. The antioxidant study mainly has been done with DPPH method of assay. Also the in-silico study of the isolated active constituents responsible for the antibacterial and antioxidant activity from the plant extract have been reported in less numbers. Hence, considering the information mentioned above, this study was designed to evaluate antioxidant study with peroxide method and antibacterial activity of chloroform extract of the plant material followed by the in-silico study of the reported active constituents responsible for the activity.

MATERIALS AND METHODS

Materials

Methanol (Merck, India), Ethanol (Lobachem, India), Chloroform (Lobachem, India) were used during the extraction process. Gallic Acid (Lobachem, India) and Folin- Ciocalteu Reagent (Lobachem, India) had been used for the phenolic content estimation of the extract and Hydrogen Peroxide (Merck, India) was used for the antioxidant study by peroxide method. Hydroxy Propyl Methyl Cellulose (Lobachem, India), Propylene Glycol (Lobachem, India), Propyl Paraben (Lobachem, India), Methyl Paraben (Lobachem, India) were used for the formulation of herbal extract. The plant sample i.e. leaves were collected and air dried under shade at room temperature, ground with electric grinder intofine powder and stored in air tight container for further use. Powdered sample was mixed with methanol: water of 4:1 ratio (solvents) for extraction in 1:1 ratio. After that the material was filtered by using Whatman No.1 filter paper and the filtrate was mixed with (2-3) drops of 2M HCl and then mixed with the equal volume of chloroform as same as of filtrate. After the formation of bottom organic layer, it was taken and separated followed by evaporation of the solvent for obtaining the dried residue. The resulting chloroform extract solution was used for further antibacterial and antioxidant activity [5].

Phyto chemical screening of Extract

Following phyto chemical tests has been carried with the extract:

Terpenoids Test
Salkowski test

Dry extract was mixed with chloroform and few drops of conc. $H_2SO_4$was added, if red-brown colour formed at the interface can confirm the presence of triter penoid.

Alkaloid's Test
Dragendorff test

Few drops of Dragandroff's reagent was added to the 2 ml of the filtrate containing the extract, the formation of a reddish brown precipitate can signified positive result.
Wagner's test: Small amount of extract was mixed with few drops Wagner's reagent where formation of reddish brown precipitate can confirm positive result.

Hager's test

Small amount of extract was mixed with few drops of Hager's reagent and the formation of yellow colour precipitate may indicate signified positive result.

Mayer's test

Few ml of extract was mixed with few drops of Mayer's reagent where the formation of a creamy precipitate may confirm positive result.

Glycosides Test

If the extract gives positive result to Fehling (Fehling test A and Fehling test B) solutionthen it can confirm the presence of glycoside part.

Flavonoids Test

Ammonium test

Small amount of extract was mixed with dilute ammonia solution (1 ml, 1% v/v) and it was allowed for layer separation. If yellow colour is seen in the ammonia layer it may signified positive result.

Alkaline test: If small amount of extract was treated with a few drops of 20% (w/v) sodium hydroxide solution, the generated dark yellow material, which becomes colourless by the addition of dilute hydrochloric acid may signified positive result.

Steroids Test

Salkowski test

Small amount of extract was mixed with 2 ml of chloroform and 2 ml of concentrated sulphuric acid, if the generated chloroform layer was red coloured and the acid layer was yellow-green fluorescence in appearance it can signified positive result.

Phenols Test

Ferric chloride test: Small amount of extract was treated with 3-4 drops of 10% (w/v) ferric chloride solution and the formation of black green colour may signified the presence of phenolic compound [6].

Quantitative analysis of total Phenolic content

Quantitative analysis of total phenolic in extracts was determined with the Folin- Ciocalteu reagent. Standard used for the analysis was Gallic acid. Concentration of (10-50) mg/ml of gallic acid was prepared in methanol. Concentration of 1mg/ml of plant extract was prepared in methanol and from that 0.5ml of sample was introduced into test tubes and mixed with 2 ml of Folin- Ciocalteu reagent and 2ml of 10% of sodium carbonate solution. The tube was covered and allowed to stand for 30 min at room temperature before the absorbance was measured at 760 nm spectrometrically. The Folin- Ciocalteu reagent is sensitive to reducing compounds including polyphenols, thereby producing a blue colour upon reaction. This blue colour is measured spectrophotometrically. Accordingly, total phenolic content was determined [7].

Antioxidant activity of the plant extract

A solution of H_2O_2 (40 mM) was prepared in phosphate buffer (100 mM, pH 7.4). Extract (1mg/ml) was added to a H_2O_2 solution (0.6 mL) and absorbance was measured. Ascorbic acid was used as standard/positive control. Samples without hydrogen peroxide were used as a negative control. Absorbance was determined spectro photometrically at 230 nm. The abilities to scavenge the hydrogen peroxide were calculated using the equation: % scavenged (H_2O_2) = $(A_o - A_1)/A_o \times 100$ Where A_o is the absorbance of the control and A_1 the absorbance of the sample[8].

Antimicrobial assessment

The antibacterial activity was carried out using disc diffusion method. Bacterial strains viz*S. aureus* and *P. aeruginosa were* purchased from Microbial Type Culture Collection and Gene Bank (MTCC) Chandigarh. Bacteria was cultured in sterile nutrient broth medium which had been autoclaved at 121°C under a pressure of 15 atmospheres for 15min. and left to grow for 48 h at 37°C in an incubator. The bacterial cultures obtained were diluted with autoclaved Nutrient. This culture served as the inoculums for the antimicrobial experiments. For the evaluation of antibacterial property nutrient agar plates were prepared by mixing (28 g) in 1000 ml distilled water boiled to dissolve the medium completely. Nutrient agar solution was sterilized by autoclaving at 121°C for15 min at 15 lb pressure. After cooling (45°C), agar solution (25 ml)were poured into sterilized Petri dishes and left to solidify. Agar plates were inoculated with an overnight bacterial culture, using spread plate method after appropriate serial dilutions. The plant extract was aseptically put into the wells (100 µl approx.) made in agar plates making lawns of different test cultures viz.*S. aureus* and *P. aeruginosa*. The Nutrient agar plates were then incubated at 37°C for 24 h. The diameter of inhibitory zone surrounding disc and antimicrobial activity of the plant extract solution (2mg/ml and 3mg/ml) was then measured after 24 hours. Two cross sectional points and the average was taken as the inhibition zone and the

size ofthe zone diameter was measured in millimetres. The plates were then photographed individually. The results were compared with the standard drug, Streptomycin. [9-11].

In-silico study

Molecular docking method has been used to identify the phytoc hemical from the plant extract that act as a ligand and form a strong covalent bond with the microbial protein to successfully inhibit the microbe. The discovery studio module of the biovia software is using for identify molecular interaction and perform molecular docking. In this process, first the pdb files for the phyto chemicals (Kaempferol) found in the *Bixa orellana* plant were downloaded from the website drug bank .The protein3-oxyacyl-[acyl carrier protein] reductase (FabG) for unknown ligand data base code(4BNW)was collected fromRCSB protein data bank. Molecular docking was done using the HDock Server.The enzyme molecule was treated as the receptor molecule and the phyto chemical was treated as the ligand. The high positive value of those indicators presented a good interaction between the ligand and the receptor. Thus, the interaction with high values might indicate the major phyto chemical responsible for curing the disease [12]. Kaempferol interact with3-oxyacyl-[acyl carrier protein] reductase (FabG) therefore inhibiting the biosynthesis of fatty acids by Pseudomonas aeruginosa and responsible for antibacterial activity.

Method of formulation of herbal extract gel

The required amount of gelling agent was accurately measured and dispersed in a small amount of water with continuous stirring to produce a uniform dispersion. Then the drug was dissolved in a suitable solvent here using propylene glycol and added to the above dispersion. Other substances such as methyl paraben and propyl paraben were also added with continuous stirring. The final weight of the gel formulation was adjusted to 10 g with distilled water. The gel was stored in container with wide mouth.

Evaluation of gel formulation
Physical Characterizations

The composition of gel using different gelling agents tested for colour, odour, homogeneity, in which the gels were placed in containers.

Measurement of Surface pH

The pH formation of gel was measured using a digital pH meter. 1 g of gel was dissolved in 25 ml of distilled water in a beaker. The electrode was then immersed in the beaker solution and allowed to simmer for 1 minute and further reading was observed.

Spread ability

Indicates the level of area where the gel spreads easily when applied to the affected skin. The therapeutic potential of the gel also depends on its spreading value. It is periodically displayed in seconds taken by two slides to move from the gel placed between the slides under the direction of a specific load (20 g). The formula for calculating gel spread ability is: $S = M * (L / T)$
Where,
M = Weight tied to the top slide (20 g)
L = Length of the glass slide slipped
T = Time taken to split the slides.

Tube Extrudability

In this experiment was taken a closed folding tube containing the composition of the ciprofloxacin gel. The gel was pressed tight at the end and a clamp was placed at the end of the tube to prevent any loosening. A weight of 500 g was placed on tube and removed from the cap. The gel was pulled out. The formula for calculating tube extrudability is: $E = (M / A)$

Where,
E = Tube extrudability
M = Weight applied on tube (500 g)
A = Extrude gel area [13].

RESULTS AND DISCUSSIONS

Phyto chemical Screening
The result showed that the chloroform extract has primarily flavonoids and phenolic part which is generally important for antibacterial and antioxidant activity. *Ocimum tenuiflorum* was used as positive control to find out the validity of the reagent used for phyto chemical screening.

Quantitative estimation of phenolic content
The absorbance value of the plant material is 0.911Now by plotting the value on the equation the conc. was found out to be is 63.26 ug/ml.

Antioxidant assessment
Percent Scavenged; % $(H_2O_2) = [(A_0 - A_1)/A_0 \times 100]$
Ao= Absorbance of the control = 0.515
A1= Absorbance of the plant sample = 0.235
So according to equation
0.515- 0.235 = 0.28/0.515=0.5436×100 = 54.36%.
From the above result it has been seen that the plant extract has showed significant effect in the dose 2mg/ml.

In-silico Study
These are docking score of 10 modules involving docking of ligand and receptor. Module 1 shows the least value so it could be judge as the best fit.

CONCLUSION

According to the results obtained in this investigation, it can be concluded that the chloroform extract of the selected plant entity is having the moderate antibacterial activity in two different pathogenic species. Also the plant extract shows the antioxidant activity have been measured spectro photometrically which may cause scavenging of free radicals forms inside the biological systems. Total phenolic content have been measured which may influence the both antimicrobial and antioxidant activity. Insilco study has been done for a specific pathogenic bacteria enzyme whose activity can be blocked by a reported phyto constituents leading to the antibacterial activity. Herbal extract formulation has been prepared with its evaluation of physicochemical properties. In future the herbal formulation can be tested for the antibacterial activity and further Insilco study can be done with different phyto constituents responsible for the different activities if the protein/enzyme structure of the pathogenic entity is known, responsible for the different types of diseases.

ACKNOWLEDGEMET

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Table 1: Composition of Gel Formulation

INGREDIENTS	FORMULATION (g)
Plant extract (dry)	1
Hydroxy propyl methyl cellulose	1
Propylene glycol	2 ml
Methyl paraben	0.1
Propyl paraben	0.2
Distilled water	upto 10

Table 2: Phyto chemical Screening

Plant Name	Terpenoids	Alkaloids				Glycoside	Flavonoids	Steroids	Phenolic content
		D	H	M	W				
Putranjiva roxburghii	-	+	-	-	-	-	+	-	+
Ocimum tenuiflorum	+	+	-	-	+	+	+	+	+

D= Dragandroff's reagent   M= Mayer's reagent
H= Hager's reagent   W= Wagner's reagent
(+) signify positive result
(-) signify negative result

Table 3: Uv-Spectroscopic analysis of Gallic acid

Conc. of Gallic acid(ug/ml)	Observed Absorbance
10	0.087
20	0.286
30	0.471
40	0.532
50	0.747

Table 4: Assessment of Antibacterial activity

Name of the Drug/Extract	Name of the bacteria	Zone of the inhibition	
		2mg/ml	3mg/ml
Control	*S. aureus*	3.2 mm	-
	P. aeruginosa	2.9 mm	-
Plant Extract	*S. aureus*	5.2 mm	2.6 mm
	P. aeruginosa	2.4 mm	-

Table 5: *In silico* assessment

Summary of the Top 10 Models										
Rank	1	2	3	4	5	6	7	8	9	10
Docking Score	-183.75	-180.56	-180.11	-174.28	-157.35	-156.37	-155.19	-144.30	-142.44	-141.53
Confidence Score	0.6626	0.6482	0.6462	0.6191	0.5367	0.5318	0.5259	0.4715	0.4623	0.4578
Ligand rmsd (Å)	50.48	35.19	34.91	49.67	40.37	46.54	41.31	49.74	38.62	50.65
Interface residues	model_1	model_2	model_3	model_4	model_5	model_6	model_7	model_8	model_9	model_10

Expected Confidence score- 0.5-0.7.

Table 6: Physical Characterizations of Gel formulation
Physical characterizations

FORMULATION	COLOUR	ODOUR	HOMOGENECITY
F1	Yellowish white	Pleasant	Homogenous

Table 7: Surface pH of Gel formulation

Measurement of surface pH

FORMULATION	SURFACE pH
F1	6.0

Table 8: Spreadibility of Gel formulation

Spreadability

FORMULATION	SPREADIBILITY (g.cm/sec)
F1	12.8

Table 9: Tube Extrudability of Gel formulation

Tube extrudability

FORMULATION	TUBE EXTRUDABILITY (g/cm²)
F1	74

F1 =Plant extract

Fig 1: Standard curve of Gallic acid

Fig 2:Standard drug on S. *aureus*

Fig 3: Standard drug on *P. aeruginosa*

Fig 4:Plant Extract on *S. aureus*

Fig 5: Plant Extract on *P. aeruginosa*

Fig 6:Protein structure of 3-oxyacyl-[acyl carrier protein] reductase (FabG) for unknown liganddata base code

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Fig 7:Binding site of ligand in enzyme structure

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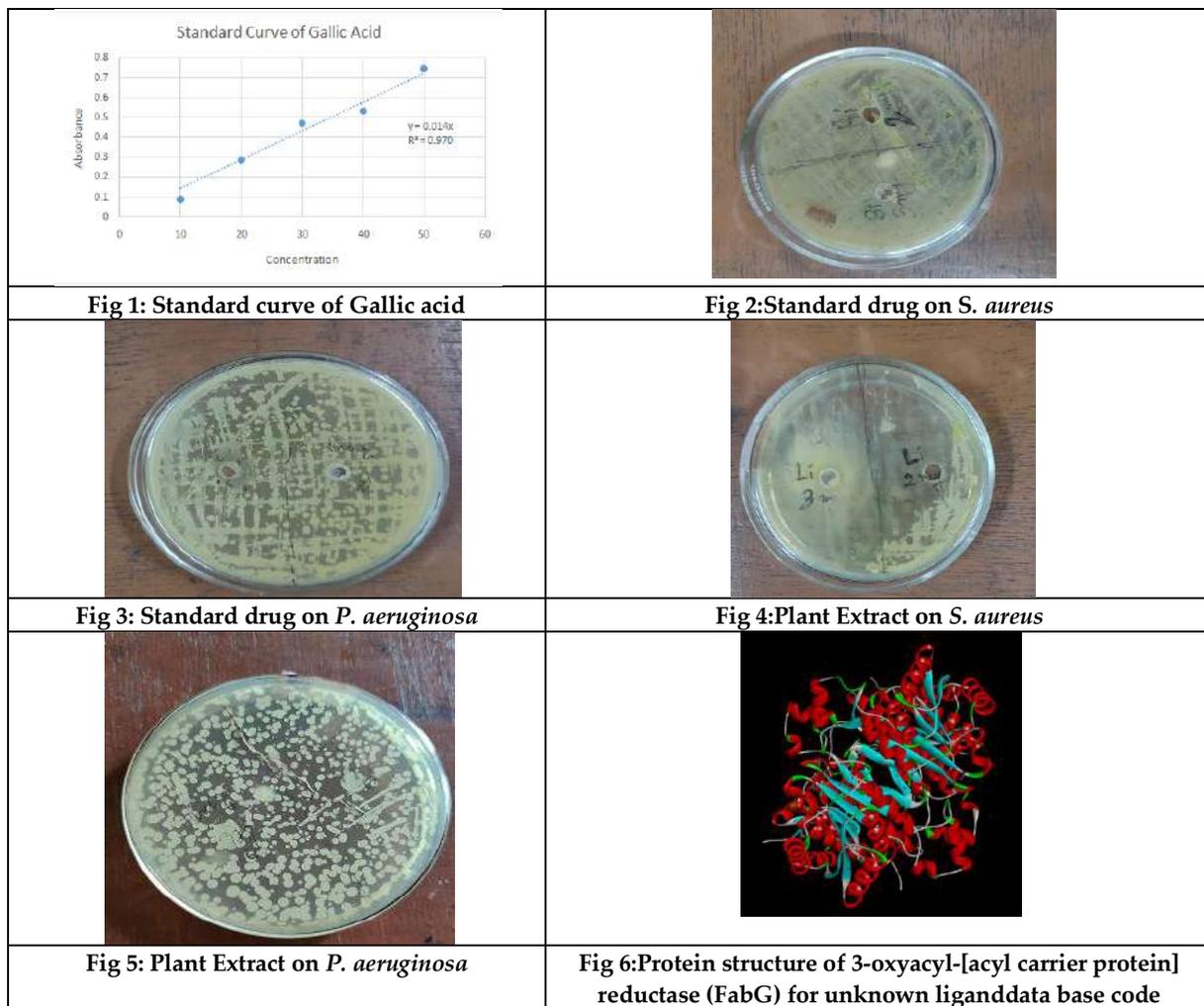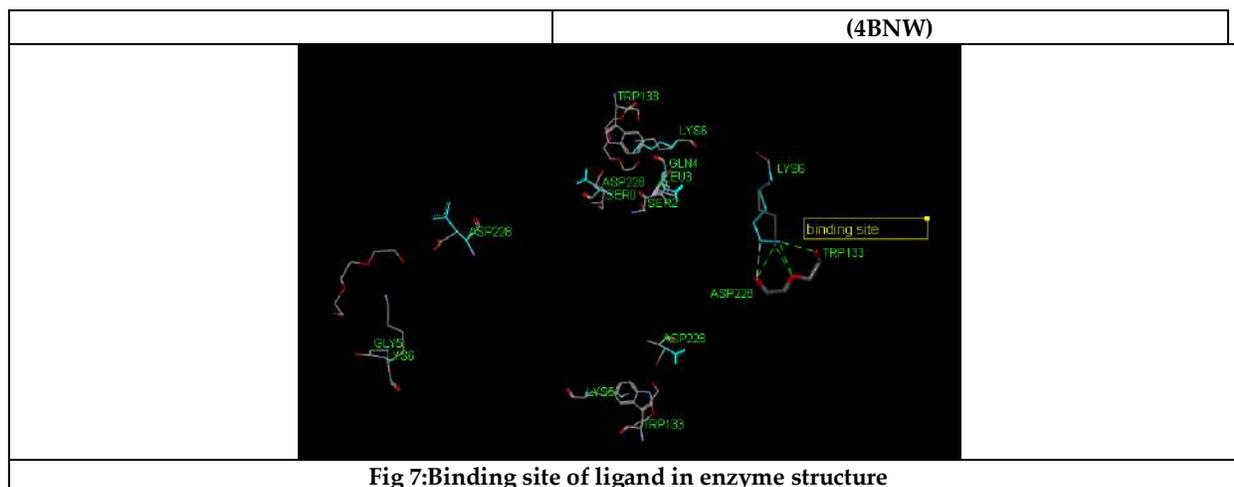
X-Ray screening in Mobile Medical Unit Vans for Tuberculosis (TB) through Artificial Intelligence Technology in Greater Chennai Corporation, Tamil Nadu

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ABSTRACT

Early and correct diagnosis of Tuberculosis (TB) are very important to end TB. Chest X-ray (CXR) is an important tool for screening TB and confirm the diagnosis in fewer situations. Greater Chennai Corporation using Mobile Diagnostic Units (MDUs) fixed with Xray-with AI. The objectives of the study were to find out the X-Ray screening performance in MDU vans using AI tools in GCC, Tamil Nadu. Artificial intelligence (AI) used to increase access to quality TB screening diagnostics in high-risk locations. Genki-AI powered Public Health Screening Solution from Deeptek was used for TB screening after uploading CXR images from MDU. X-rays taken have been uploaded in AI software and the results been available immediately after uploading. A radiologist reports also generated to take further course of

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action. There were 79462 CXR taken from April 2019 to April 2022 from 7 MDU vans. Among 3.4% were identified as suggestive of TB, 1.4% as old TB, 0.89% as COVID (from 2020) and 7.2% with other chest abnormalities. All positive reports by AI were supplemented with radiologist's report. AI helps in faster screening for further public health action and eliminates the challenges of availability of functional X ray, interpretation, and reporting.

Keywords: Tuberculosis (TB), Chest X-ray (CXR), screening, Artificial intelligence (AI), Machine learning, Public Health program, NTEP

INTRODUCTION

Tuberculosis (TB) is a public health problem which needs sensitive tools and technology for early diagnosis and treatment. Artificial Intelligence (AI) is defined as algorithms encoded in technology to learn from the given data which are given to a system to do automated tasks without every step in the process having programmed explicitly by a human [1]. AI systems gained more importance in the last decade because of their vast potential in improving economic value and helps to alleviate the social challenges. Currently India doesn't have an AI framework. The concept of responsible AI for all is made in India as an ethically sound and ready to implement to benefit the community at its best [2]. Many countries use AI for screening the diseases, rapid diagnosis, clinical care, discovery of drugs and management of public health.[3]. Tuberculosis (TB)remains the leading cause of morbidity and mortality in developing countries, including India[4]. Because of high TB burden in India many interventions are underway to eliminate TB. In India in 2021 there were 2.14 million TB cases notified which was 18% more than 2020 but 18% less from the baseline data [5]. Various intervention simplemented by the National TB elimination program (NTEP) of India to increase case detection by intensified door-to-door Active Case Finding helps to screen more presumptive patients and ensure no missing of any household, increased diagnostic capability to strengthen detection efforts through molecular and digital tools [6].

Undiagnosed pulmonary TB contributes significantly to transmission, and delayed diagnosis also worsens treatment outcomes of patients, both will increase mortality and morbidity[7].For TB Chest X-ray (CXR) is one of the screening tools to increase the sensitivity of diagnosing TB [8].Limitations of using CXR in the community setting includes functional X ray availability, interpretation, and reporting, mobilizing the beneficiaries, cost of tests. The usage of chest x-ray as a screening tool has been limited by high inter-reader and intra-reader variability and moderate specificity, as well as limited availability of radiologist [9]. As mentioned above, usage of AI in public health programme is very much limited. In high-risk locations of Chennai Greater Chennai Corporation (GCC) has started programmatic intervention "TB Free Chennai Initiative" (TFCI) to increase access to quality TB screening diagnostics[10]. The intervention includes digital chest x-ray via mobile diagnostic unit (MDU) vehicles followed by artificial intelligence-assisted interpretation of the digital chest x-ray. The objectives of the study were to determine the X-Ray screening performance in MDU vans using AI tools in GCC, Tamil Nadu.

MATERIAL AND METHODS
Setting and Participants
The type of study was a cross sectional retrospective study. Duration of the study was one year with data extracted from April 2019 to April 2022. This study extracted the information of X-rays which were taken in Mobile Diagnostic Vans (MDU) of Greater Chennai Corporation (GCC). Both the X-ray results and results of Artificial intelligence data were compiled.
Process
For presumptive TB cases and high-risk groups of populations, MDU set of arrangement is used to screen in uncontrolled diabetes patients, smokers, people who have HIV/AIDS, Slum dwellers, chronic diseases, old TB cases and who are identified during vulnerability mapping. The vans are fixed with portable X ray. An artificial

Intelligence system was installed in this was to enable the screening of X-ray so the X ray's which has high index of TB in AI results, will be sent for other tests for TB without any time delay. A radiologist reports were also arranged for cross confirmation of the positive results of AI. People with negative X-ray results were being followed up and X-ray suggestive of TB were subjected for other sputum test (NAAT).Based on the sputum test results the patients were started on TB treatment as microbiologically confirmed TB case or clinically diagnosed TB case after medical consultation. The process of MDU operation is given in the schematic diagram (Figure 1). Based on the vulnerability mapping and landscape of TB data, the micro plans for each van were developed. For community preparation, the visit plans were shared to the field staff and front-line workers well head of visit. Field staff conducted the public announcement and household visits before. The eligible persons were invited to the camp. Direct walk-in clients were screened for TB and X ray was taken. In the MDU camp registers, all the process was well documented. X-rays taken for the day were uploaded in the cloud system of AI in DICOM image format and the AI results were available immediately. The AI was assisted by Deeptek uses the special technology called Genki public health screening Solution, Edge. It is called "AI+Expert in the loop" and gives an "end-to-end imaging workflow". It covers 17 chest pathology types, including TB and COVID 19 like infections. Three key highlights were classified, localize, and quantify lesions. The other cloud techniques named Augmento, an extended cloud-based AI system is also available[11].

Data collection and statistical analysis
MIS system of AI was given with the demographic details of the beneficiaries, X-ray images, AI results and Radiologist opinion. All the above information was downloaded as per the given timeline. The downloaded information was categorized as TB suggestive and TB non suggestive. Descriptive statistics were applied.

Ethical and administrative approval
Ethical approval was obtained from the Institutional Ethics Committee of Madha Medical College and Hospitals, Chennai. The administrative approvals were obtained from the Commissioner of GCC Tamil Nadu.

RESULTS

Demographic details of beneficiaries
In total 79,464 beneficiaries availed X-ray services in the MDU vans. Among them 52% females and 48% were males. Among attendees 80% were availed X-ray services in morning camps only. Children and old age person's count were low. The maximum attendees were between 40 to 60years. Operational pattern of MDU In 2009, total 7 vans were in the field and 27714 people utilised services; In 2020,5944 beneficiaries availed services through 5 vans; There were 34936 participants in 2021 availed services through 6 vans and 10868 utilized services in partial 2022 through 4 MDU vans.

Pattern of disease spectrum in CXR–AI
AI gave results of various chest abnormalities including Tuberculosis and old Tuberculosis. The pattern of diseases identified through AI is given in Table 1. COVID-19 disease pattern was introduced from 2020 onwards. Out of all X-rays taken, 56.83% (n=69004) were normal, 3.46%(n=2750) suggestive of TB, 1.4%(n= 1122) old TB, 0.48%(n=378) poor quality images, 0.89%(n=4650) COVID-19 suspected X rays and 7.2% (n=5743) having other chest abnormalities (Table 1). COVID-19 was inbuilt in AI system from 2020 onward only.

Pattern of TB and old TB
Among all, 0.5 % of images taken were excluded from analysis because of poor quality. The TB positivity rate pattern in various years is given in Figure 3. The TB positivity rate from 2019 to 2022 was 5.95%, 1.08%, 1.96% & 3.26% respectively. The overall TB positivity rate was 3.48%. Old TB positivity rate was 1.42% (Figure 2).

DISCUSSION

Current study demonstrates the usage of AI for X-ray screening of Tuberculosis in public health programme setting. Greater Chennai Corporation with the help of partner agencies taken care in selecting and evaluating the AI system for tuberculosis. The involvement of health system staff is the key in imposing the latest technologies to the common public. The current model is continuing in Chennai and adopted in few other locations of Tamilnadu and other parts of country [12,13].Their radiologist helped in giving the specialist report, so the patients were able to start on treatment without any time delay. The availability of early AI reports enables the health system to undertake various other tests without any time delay. GCC is keen to provide continuous improvement in quality of care, including treatment prescription for TB care [10]. The current model is the best example for decentralization of diagnostics to the community level. The sensitivity of TB tests is increased when we add Chest X-ray with another diagnostic tool [14].CXR plays an important role in triaging the individuals along with symptoms screening. The other tests usually in use are Sputum Smear microscopy or NAAT. This method of screening is known as targeted screening of symptomatic individuals where it yields superior result and cost-saving.ACF is one of the key approaches that can address the challenges of TB among tribal communities [15]. For diagnostic decision-making, WHO recommend computer-aided detection software like AI to read X-ray images [16].

DeepTek Genki v2 performed on a par with Expert and Intermediate Readers [17]. AI products including qXR (Qure.ai, India)) is more than 80% sensitive [18]. National Strategic Plans to eliminate TB (NSP) is ready to invest in research to develop additional new tools required to end TB and in the rapid uptake of available new tools such as automated digital chest x-ray interpretation [19].Many start-ups started supporting AI X-ray screening. [20]. Central TB division of GoI. is exploring various new interventions to address the challenges in the TB treatment cascade and improve processes and management of TB cases using AI with machine learning[21]. NITI Aayog has decided to focus AI on health care sector. Some of the high-level issues in AI usage are lack of data eco system, cost, low awareness to adaptation, privacy, and security. Most of the time it stops at academic or at research levels. Many start-ups are helping the society with low-cost technologies [22]. The current study had certain limitation and challenges. All the MDU vans were not continuously functional due to HR and other administrative problems. Few numbers of poor-quality images were reported because of poor understanding of the beneficiaries on the prerequisite of chest X ray posture. Male attendees are less in the MDU camp as they go to work outside during the camp timings. So, majority of the camps were planned in the early morning or late evenings and holidays.

CONCLUSION

In the scarcity of radiologist availability, AI helps in early case-finding using X-ray screening which helps in early public health action. With the provision of MDU services, access, and availability of resources for X-ray were further reduced.

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Table 1. Different chest pathologies identified through CXR-AI

Year	Healthy	COVID Suspect	Tuberculosis	Tuberculosis-Old	Poor Image Quality	Others	Total
2022	9542	48	354	8	121	795	10868
2021	31933	241	684	118	154	1806	34936
2020	5193	176	64	34	40	437	5944
2019	22336		1648	962	63	2705	27714
Total	69004	465	2750	1122	378	5743	79462
Positivity(%)	87.25	0.59	3.48	1.42		7.26	79084

Figure 1: AI Powered TB Screening Process in Greater Chennai Corporation

Figure 2: Year wise TB positivity pattern through AI

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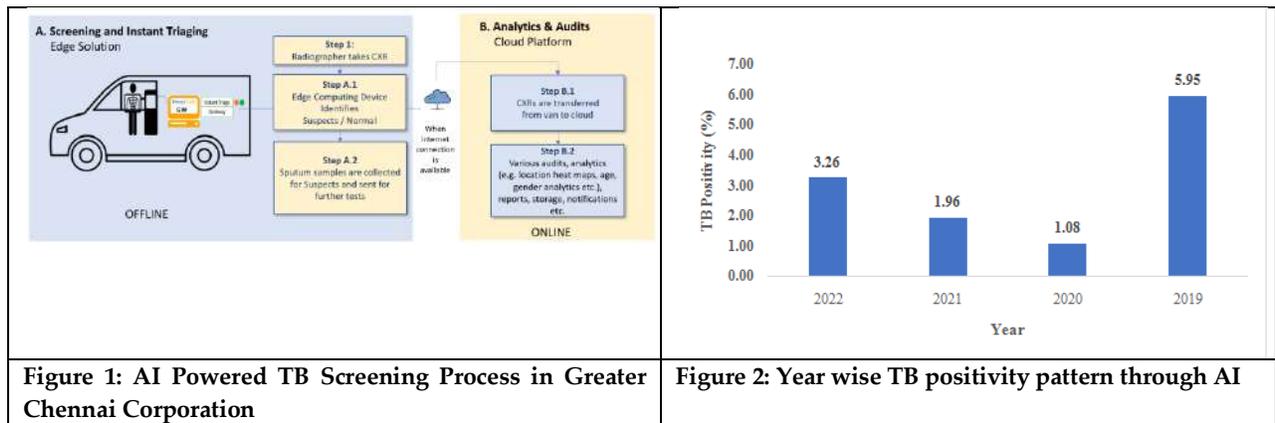
Process Automation in Women-Led Msme Units :A Case Study of Small-Scale Industries in Uttarsanda

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ABSTRACT

With the corporate world going through tough competition, business units need to constantly innovate and upgrade using the latest technology. This goes well not only with large-scale and medium-scale enterprises, but also those small-scale as well as micro-enterprises and cottage industries, mostly run by women entrepreneurs. While these women entrepreneurs are playing a vital role in the development of the Indian economy, they need to ensure they are ready to be the game-changers by moving with the time and are implementing the best practices in their business. Such technologies help in ease of production process, improvement and standarization of quality as well as wastage of resources. Also, technology can also be used for identifying newer markets and the means to reach there. With the world that has now become a global village, technology has also become the backbone of supply chain management. the Hence, the more use of technology, the higher the benefits for the entrepreneur.

Keywords: MSME, Small Scale Industries, Women Entrepreneurs, Entrepreneurship, Technology in women enterprises

INTRODUCTION

Entrepreneurship has been one of the oldest professions in the world. According to the Global Entrepreneurship Report 2023 Global Report, the number of entrepreneurs in the world is approximately 594 Million, which constitutes 7.4% of the overall global population. The number of women entrepreneurs worldwide is approximately 252 Million, which accounts for 43% of the total entrepreneurs. India leads all other countries with approximately 105 Million entrepreneurs, out of which around 15 Million are females. Therefore the proportion of female entrepreneurs in India is about 14%, which is very less as compared to the global rate. Most of the large-scale and medium-scale enterprises in India are owned by men, and the proportion of female entrepreneurship is slightly higher in Small-scale and

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Micro-enterprises, which is about 20%. These female entrepreneurs provide employment to about 25 Million persons in India. Female entrepreneurship is also higher in rural areas, as compared to the urban parts of India. With a major chunk of these units belonging to the Micro-units and Cottage Industries mostly operating from home or from unorganized set up, use of technology and process automation remains a challenge. This is also triggered by the low literacy level of such female entrepreneurs in the rural areas. With the market continuously evolving amidst increasing competition, and customers demanding better quality products, business units need to evolve by embracing technology not only to improve their production process, but also to innovate and develop newer products.

REVIEW OF LITERATURE

In [1] **Gulia, Suman (2022)**has done a detailed study on the problems faced by Indian female entrepreneurs and has also enlisted the various schemes designed by the Government of India, to provide financial assistance to female entrepreneurs. In [2] **Aggrawal, Artee; Carick, Jon; Kennedy, Jeffrey and Fernandez, Giovanni (2022)** have conducted an exploratory study to understand the plight of women entrepreneurs in India, having done indepth interviews of ten women entrepreneurs to come to their conclusions . In [3] **Saraswat, Ritwik and Lathabahvan, Remya (2020)** haveconducted an extensive study on the factors affecting entrepreneurship amongst females in India, and to understand the mindset of the people of various strata of the society, regarding female entrepreneurship. In [4] **Arya, Sadhana; Panda, Shiba and Kaur, Gurveen (2017)**have elaborated on the status of female entrepreneurs in India and they have also done a study to understand the reasons behind females taking up the role of entrepreneurs in the country. In [5] **Rajalakshmi, A. (2014)**has highlighted the role of women entrepreneurs in the development of the Indian economy, and felt the need to provide more resources to the female entrepreneurs so that they can take their businesses to greater heights.

OBJECTIVES
This study focuses on the women-led micro-enterprises and cottage industries thriving in Uttarsanda area of Kheda district in Gujarat :-
1. To understand the level of technology and automation used by them in their business set-up
2. To identify the challenges they face on ground, to adopt new technologies.
3. To ascertain whether the production capacity is being fully utilized and what can be done to overcome any underutilization.

RESEARCH METHODOLOGY
In order to have an indepth knowledge about the role of women entrepreneurs, and the overall common challenges faced by them, secondary data has been used. This is mainly through study of previous research papers on this topic, as well as information released by the Government of India. As regards to the on-ground performance of the female entrepreneurs in Uttarsanda, the authors have conducted personal interviews of 5 of the top entrepreneurs of that area. Since there is no analysis of data involved in this study, no statistical tools have been used in this context

STUDY FINDINGS
Uttarsanda village lies under Nadiad Taluka in Kheda District of Gujarat. As per the Census conducted by the Government of India in 2011, the population of Uttarsanda was 10,616 and it is estimated that the present population is upto 12,950. The literacy rate of this village was 90% as per the 2011 census, which is much better than the state literacy rate of 78% and the national literacy rate of 74%. Uttarsanda is also known for the various varieties of Papads being manufactured in about 35 micro-enterprises that have been operational in this area, most of them have been around for more than 30 years. The main speciality of these units is that most of them are run by women entrepreneurs, and it also employs a nearly 95% female workers in the entire production process. It is estimated that the total turnover of these units is Rs. 70 crores per annum. 80% of the households in this village have their relatives

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staying abroad, mainly in the USA and UK, and these NRIs/PIOs have made it a point to carry back a fair quantity of these local papads, whenenver they visit India. It is also estimated that 20% of the products manufactured here are exported. However, with all these fanfares, where does Uttarsanda stand as compared to the overall market size in the country? As per the Forst and Sullivan Analysis, the papad market in India was of Rs. 74 Billion in the year 2021, out of which 32% was catered by the organized sector whereas remaining 68% by the unorganized sector. The papad market is estimated to grow at a CAGR of 7.6%, which means reaching a market size of Rs. 100 Billion by the year 2023. Therefore the total market share of these units in Uttarsanda is roughly 1%. There is an ample scope of expanding the market share by concerted efforts. Detailed discussion and probing during the interviews of the entrepreneurs (including the units that are operational now, as well as those who operate in seasons) have come out with some interesting results.

The ground reality inUttarsanda is that only 7 units operate throughout the year. Remaining 28 units operate seasonally, mostly during the Diwali season when they consider the demand to be high. Therefore 80% of the units remain shut for most part of the year. As for these 7 units which operate throughout the year, there are some similarities in them :-

1) They have semi-automatic papad making machines of various capacities installed.
2) They have also expanded their product range by introducing various flavours and types of papads and other snacks.
3) They have their websites through which they are also catering to their online orders as well as export enquiries.
4) They use modern marketing techniques in order to promote their products through social media. Therefore they have succeeded in promoting their brand.

None of these units have any dedicated R&D activities, therefore the chances of product innovation, new product development, etc. is very bleak.
With such a huge market lying open, the main reasons why other units are still operating only during seasons, thereby causing huge capacity underutilization,are :-

1) Sticking to the some old conventional product range
2) Not willing to upgrade their production process from manual to automatic or semi-automatic
3) Lack of proper understanding of the overall market size within the country
4) Reluctance in using modern marketing techniques such as online marketing, social media marketing, etc
5) Considering exports as a cumbersome process and an activity of high risk.
6) Lack of a formal association or group that could keep them in loop with the market trends as well as other factors.

None of these entrepreneurs were in favour of creating an association or society, as they believed in operating independently. And none of them cited financial difficulties as a reason for their underperformance.
Therefore the willingness to share knowledge or to create avenues of expansion through cooperation, was totally absent.

CONCLUSION

India has been a very good market for processed food and more players are now entering the market, as these organized sector units invest in new technologies, automation, quality enhancements, etc. Papad and similar snacks have been a regular part of the Indian food habit. With such a huge market for this item, and such big scope for the organized sector to play within, the overall performance of these women-led enterprises in Uttarsanda, is not upto the mark. The need of the hour for them is to embrace technology to automate their production process, focus on R&D of newer products and variants, as well as tap the market using proper technological tools to promote their

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products. Sticking to conventional products and conventional production process would not be helpful in the long run.

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RESEARCH ARTICLE

Representation of Poverty and Social Injustice: A Journey from Rags to Riches in Aravind Adiga's *The White Tiger*

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ABSTRACT

Aravind Adiga's *The White Tiger* is a debut novel published in 2008. He portrays the socio-economic condition of modern Indian society. Adiga has tried to paint a realistic picture of contemporary India. He speaks of various issues prevalent in Indian society. India is free now but people belonging to poor communities are exploited and humiliated and are still deprived of their rights. As in the jungle timid and weaker animals are hunted similarly down trodden poor people become prey to the powerful and rich people. Through the protagonist of this novel Balram Halwai, Adiga has depicted the class struggle, poverty, and social injustice. This struggle is longing from many epochs in various forms. People rebel against such suppression and revolution brings hope of freedom. Similarly, the hero of this novel tries to break the chains of servitude. Adiga presents his hero, Balram as the face of every Indian working class who undergoes various sufferings and exploitation in contemporary India. The novel represents the journey from rags to riches of an innocent rural youth transforming into a corrupt rich businessman. Through this paper, it is an attempt to depict the traumas created socially and economically. This novel presents the quest of a man longing for freedom who becomes the victim of poverty and discrimination and finally, chooses the unethical path to get his rights by murdering his boss, runs away with the stolen money ends up with a successful rich entrepreneur.

Keywords: Struggle, Rags to riches, Exploitation, Social injustice, Poverty

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INTRODUCTION

The White Tiger won the Man Booker Prize in 2008 and was adopted in a Bollywood movie directed by Ram Bahrani. This novel reflects various hypocrisies prevalent in our society. In today's era, people are moving toward development but on the other hand, some people who are deprived and underdeveloped still exist. People from weaker sections are exploited and suffer various miseries after toiling hard. Their socio-economic conditions have made them crippled. Karl Henrich Marx, the German philosopher along with his collaborator Friedrich Engels published a pamphlet *The Communist Manifesto* in 1848to serve the rights of proletariats. Marx has discussed various consequences of proletariats, and how they are being exploited, humiliated, and alienated. In capitalist society, bourgeoises are becoming richer and proletariats are becoming poorer, due to the social structure created according to their interest. Karl Marx gave the theory of Marxism. Marxism was against capitalist society as it did not provide equal opportunities. He emphasized an equality-based classless society as the capitalist society lives for its own sake with ruling behaviour considering vermins that can be easily crushed. It becomes evident that the bourgeoisieis unfit any longer to be the ruling class in society."It is unfit to rule because it is incompetent to assure an existence to its slave within his slavery, because it cannot help letting him sink into such a state that it has to feed him instead of being fed by him. Society can no longer live under this bourgeoisie. ((The Communist Manifesto 53)

Aravind Adiga's novel *The White Tiger* deals with the themes of poverty, exploitation, social injustice, and deprivation and portrays the social and economic context of contemporary Indian society. He unveils Indian culture based on the division of class. The hero of this novel cannot put up with social injustice and inequality and comes out from the pit of slavery. His journey begins with the intolerant drowning phase, so he grabs it ferociously, making his life move like a boom reaching its horizon from rags to riches. Balram Halwai, the protagonist of this novel lives in a village, Laxmangarh in Gaya, Bihar. He belongs to a marginalized community who has to toil hard to earn his livelihood and face deprivation in terms of basic rights like education, and health. Balram's father, Vikram is a rickshaw puller. He wanted to give education to his children but his condition never allowed and was helpless. Due to the inadequacies of the medical department, he had to pay for the ignorance of his life. He didn't get proper treatment to cure tuberculosis and died with his barren hopes. He always wanted his sons to study and come out from this trench as many fathers like him had spent their whole lives like donkeys carrying out the burden. He was aware that education is the medium to remove ignorance and can uplift them."My whole life, I have been treated like a donkey. All I want is that one son of mine - at least one - should live like a man." (Adiga 30).

People of lower strata are maltreated by the greed of higher-class people. In childhood, Balram was compelled out of poverty to abandon his education and work in the fields. Poverty didn't give him a chance to study and uplift his upcoming generation. Being a vivacious boy since childhood gained him nothing. Due to his intelligence and cleverness, he was named as "White Tiger" by the Education officer. His high spirit has pushed him forward as he has a strong urge to attain the desires of his life by crossing the boundaries of slavery. The history speaks about the profession associated with caste and economic status. In today's era, every citizen wants to educate their children to have better opportunities and a good life, belonging to any strata. According to article 12 to 35 contained in part 3 of the Indian constitution, the Government has guaranteed individuals, the fundamental rights acts and can exercise them. The scenario of rural is unspeakable. The peasants who used to feed the people by means of agriculture are now finding difficulty in their survival. This is unfortunate that peasants who are the producers and agriculture base of our country come to the city to work and fetch humiliation and exploitation. Social and economic inequality is like a quagmire where the poor once entangled will never come out. They become prey to the capitalist class. In greed of achieving more, their desires become limitless and result in the exploitation of workers. After working hard with no fixed hours, workers receive meagre wages which are not sufficient to fulfil their basic needs. This is a pitiful condition for workers who are deprived of basic needs. Adiga has depicted exploitation by landlords, where Balram along with his family was also exploited by the landlords. This oppression is mentioned by Karl Marx and Friedrich Engels in *The Communist Manifesto*, "It has but established new classes, new conditions of oppression, new forms of struggle in place of the old ones."(32) The landlords are four brothers and are the chips of the same block. The whole

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family works in the field of Stork to repay the loan amount. The amount of loan takes a gigantic form which is easy to disburse but cannot be closed quickly. This is a thirst for greed to gain more and more with less investment. These landlords exploit peasants and poor workers differently. They are no less than the Britishers who left our country long ago but their existence has not faded as the place has been taken by the rich people. According to Balram poor cannot be free until they are in the clutches of the corrupt hypocrites. "only a moron would think that we became free then." (Adiga 63). Many Indian renowned writers have tried to highlight severe issues in our society through their literature. Munshi Premchand's *Godaan*, based on the theme of socio-economic deprivation, *Kafan* highlights the realities of poverty and the struggle of the lower class. Mulk Raj Anand's *Two Leaves and a Bud* presents the real picture of the sufferings and exploitation of a labour class at the hands of Britishers and Landlords. A few more novels like *Coolie* and *Untouchable* are also based on themes of poverty, exploitation, and social injustice. The novelist Kamala Markandaya's *A Handful of Rice* also portrays poverty and discrimination in Indian society where rural youth Ravi Shankar migrates to the city in the hope of better opportunity but his condition deteriorates and even unable to arrange food for his family. Later, Balram started working with his brother at a tea stall.

Balram has a hope to get equality and believes in himself to accomplish it. However, he could not study much but believes in gathering knowledge. So, he usually eavesdrops on the conversations of customers and keeps himself updated. He has always kept his hopes high and greed to have a better future. Balram indifferent to others adopts all means in his life that can be fruitful to him. Balram learned to drive. Along with this skill, he learned the art to survive in the jungle. The skill of driving fetches him a job at Stork's house as a driver. These Stork brothers are the dictator landlords of the village. They didn't leave any means to exploit villagers. Adiga through these landlords has portrayed landlords as an agent to exploit peasants. Like other peasants, Balram and his family were also the victims at the hands of the landlord. Due to social dominance people rebel out of tyranny. Soon he realized that the reality of the ruthless place is that people with wretched poverty cannot survive in the jungle. One has to be a sycophant and follow the corrupt life to survive. Balram also does the same by taking an unethical path. After getting a job as a driver, Balram shifted to Delhi where he lived in a servant quarter along with an old driver, Ram Prasad. This driver also suffers and becomes the victim of racism. He hides his religion and works at Stork's house. Being capable and skilful he had to hide his identity to save his job. This is the reality of haves-not, having no rights of their own, where caste and religion are superior to their skills. In *Marx and Marxism*, the writer expresses his thoughts regarding religion, "Religion is not merely a ruling-class invention foisted onto a passive and innocent people. To abolish religion, one had to abolish an irrational and unjust society." (PW 19 Chapter 1). Apart from driving these servants do other menial work. The novelist has depicted various issues in our society by emphasizing caste, religion, poverty, and orthodox which is a trap of bondage. Through the characters in the novel, he has also brought racism to light, one of the most vogue issues in our society.

In *The Communist Manifesto*, Marx and Engels stated about the treatment of the poor, "for exploitation, veiled by religious and political illusions, it has substituted naked, shameless, direct, brutal exploitation." (36) Adiga has presented two sections of society through his characters Balram(poor villager servant) and Ashok(corrupt businessman) who contrast in every manner. "Society as a whole is more and more splitting up into two great hostile camps, into two great classes directly facing each other: Bourgeoisie and Proletariat." (*The Communist Manifesto* pp. 33). The author brings this corruption into the limelight where people belonging to the affluent class commit crimes and servants and drivers are put behind bars in their places. He shares that in Delhi majority of jails are filled with these victims and real culprits are roaming freely. These rich culprits believe that if they pay, they own the servants. Such incidents are a bitter truth of our society which is casually practiced in our society. This is indirect exploitation and humiliation of the lower class by upper-class people. Our country is free but people have not been freed completely. Today people are suppressed in many ways. Usually, rural people migrate to the city in the hope of a better life but are unaware of the fact, that due to their migration cities are overflowed and face severe economic issues that affect migrants adversely as said by Paul Kurtz, in the book *Humanist Manifesto 2000.*This is an instance to show the extent of suppression and rule over the proletariats. These upper starta are like vultures, always seeking a chance to grab their prey. Adiga describes the dual sides of India: Dark and Light. Darkness is where unprivileged people live and is associated with the struggles and miseries of workers. It is a place where children are born but

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there is no one to take care. The protagonist of this novel has no name in the beginning. His parents paid no attention to naming him as earning to survive was a priority than naming the child as belonging to darkness. And those who are rich by money live in light with all sorts of comforts. The people belonging to darkness do all the basic work which may called menial work. The novel shows the lifestyles where the rich enjoy a luxurious life with air conditioning, living in apartments and enjoying other luxuries, whereas the poor are staying under bridges with no roof above them. "you can tell by their bodies, filthy faces, by the animal like way they live under the huge bridges and overpasses, making fires…." (Adiga 119-120) According to Adiga, people migrate from villages to cities seeking employment, where they work as drivers, cooks, maids, labourers, and do other work with little amount. "These people were building homes for the rich, but they lived in tents covered with blue tarpaulin sheets, and participated into lanes of sewage. It was even worse than Laxmangarh…The slum ended in a sewer…." (Adiga 260) The author of *The White Tiger* sarcastically shows when the rich go for dieting and fasting to be lean and thin but the irony is that the poor are already thin and curved out of poverty. On one side India is moving towards development with an increasing economy but on the other hand conditions of the poor are stagnant.

In this novel, Balram becomes the victim of the ruling class. It is believed that the poor are not masters of their mind and those who pay them are their masters and considered as God. "We have left the villages, but the masters still own us, body, soul, and arse. Yes, that's right. We all live in the world's greatest democracy here. Doesn't he have the right…? He has no sense of privacy." (Adiga 169,189) Balram refuses to live in a rooster coop where people like him are suffering from poverty, deprivation, and various miseries. He wishes to move beyond the social ladder by breaking the orthodoxy of traditions and free from the fetters of bondage. As Balram takes a step forward to break slavery, he is pushed back in a reversed direction toward deteriorating conditions. Balram was asked to accept a crime which he did not commit. His corrupt boss, Ashok allures him with different offers, and other Stork members threaten him indirectly. In reality, the crime was committed by an American lady, the wife of his master Ashok. She runs over a child with her car in a drunken state. It is the same thing as paying the bill in someone else's name, instead of realizing the guilt, Stork's family uses hook and crook to force Balram to accept this crime and try to frame him as a murderer as Go to old Delhi, behind Jama Masjid… Hundreds of pale hens and brightly coloured roosters, stuffed tightly into wire-mesh cages, packed as tightly as worms in a belly, peeking each other…, the whole cage giving off a horrible stench- the stench of terrified feathered flesh. On the wooden desk above this coop sits a grinning young butcher, showing off the flesh and organs of recently chopped-up chickens, still oleaginous with a coating of dark blood. The roosters in the coop smell the blood from above. They see the organs of their brothers lying around them. They know they're next. Yet they do not out of the coop (Adiga 173)

Balram has tried to fulfill his desires by being honest but the dominancy of the capitalist class keeps no means to crush his desires. He kept his spirit high and tried hard to become successful. He was an innocent youth belonging to a rural area who simply came to the city to have a better life. But this society has snatched his innocence and taught him social hypocrisy by leaving him corrupt. He therefore justifies his motive by writing a letter to the Chinese premier, Wen Jiabao declaring not to live whole his life like an underdog. "I cannot live the rest of my life in a cage." (Adiga 278). So, he rejects the tyranny of these rich hypocrites and stands rebellious against them to fight for a better life as the limit of tolerance was crossed and he cannot stand up more with injustice and poverty. He also follows the same path of corruption as seen and learned earlier to fill his appetite starving for his own identity. Soon he gets the chance, and his anger bursts on his boss Ashok. He picks the wrong way by killing his master and running away with his money to Bangalore where he converts into a rich successful entrepreneur. Out of compulsion, Balram accepts the corrupt ways of life, which is well depicted from the statement "I was corrupted from the sweet innocent village fool into the citified fellow full of the debauchery, depravity and wickedness." (Adiga 167) Balram always observes his boss, Ashok bribing corrupt politicians to run his work without hindrance. His mind always raises a question…why can't he benefit financially like others opting for corrupt means…Adiga emphasizes the incidents occurring and how they affect the protagonist. Balram was always seeking the chance to break all social fetters escape from the suppression of this society and finally become part of this ruthless society. In his journey, he encounters the social structure and its contrite practices, which affect workers adversely. Balram revolted against the capitalist society as the revolution was only the way to move out of it. "Only by revolution, he now believed, could

capitalism be overthrown; only the proletariat was capable of undertaking that action."(PW21 Chapter 1). Balram after being surrounded by the clutches of his master and escaping from being hatched by conspiracy, didn't find any way out. So, he justified himself by murdering tyranny in the form of Ashok because his fight was against exploitation and poverty. His desires are now endless as money has given him feathers to reach the top strata and believes in changing his destiny by himself. He never wanted to be swamping like fishes and ultimately, escaped from the rooster coop and saved himself from being butchered at the hands of butchers. Finally, Balram shows his power and proves his name "White Tiger" by hunting the lamb (Ashok) as this Tiger has a quest for freedom and wants to be independent. White Tiger has taken a leap of success. This transformation from Halwai to a rich businessman with a new identity, who once was a driver of his master and is now the master of all drivers. "a driver to a master but now a master to a driver" (Adiga 302). He is the same child who was once scared of small reptile lizards on the wall of a classroom and now he becomes a monster who can gulp a man also.

Balram has defined the society as a jungle that is full of wild animals, strong, ferocious, and dangerous where weaker and timid get hunted. People with big bellies have been denoted with wild animals who keep eating and growing up their bellies. This law of the jungle applies in the real world with two destinies eat or get eaten up. At the beginning of narration by the narrator, Balram asserts "I am tomorrow" (Adiga 04), and proves himself as "I am light now, but I was born and raised in darkness." (Adiga 14) This novel is a journey full of struggles of a poor innocent villager who did not compensate for his desire to reach a higher social status. He proved that rights can't be begged, sometimes revolution is important to start. His rebellion was not for a single person but against the tyrant sections. He achieved climbing the social ladder but has paid huge for it. His success has paid him isolation with no companions and left him with the dark secret behind his successful career. He is now rich with no morals as his hands were stained with blood.

CONCLUSION

Aravind Adiga's *The White Tiger* is the portrayal of the dark side of Indian society through the narration of a village boy Balram Halwai and his journey from rags to riches. Rousseau has stated well that, Man is born free but everywhere in chains. Adiga depicted the voices of a darker phase of the underclass and broke the myth that social evils have no existence in our society. The roots of these evils are scattered all over and are affecting our society. This novel portrays a similar picture of underclass people who suffer various issues like poverty, exploitation, and social injustice. Adiga has portrayed a real picture of Indian society through his hero Balram Halwai, the journey of darkness from the darkness of the village to the light of richness as an entrepreneur in Bangalore. His journey from rags to riches, who runs from poverty to have a better future, undergoes various ups and downs in his job and faces social injustice. Finally, he vented out the anger in his heart by ending his source of torture and exploitation by murdering his boss, stealing a bag full of money, and becoming a rich entrepreneur in the city of Bangalore by bribing police to make a final escape from poverty.

DECLARATION

My assigned MCN no is- IU/R&D/2023-MCN0002236.

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RESEARCH ARTICLE

Status of Horticulture in Lakhimpur District of Assam with Special Reference to Laluk and Narayanpur ADO Circles

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ABSTRACT

The cultivation of fruits and vegetables, commonly called horticulture has been quite successful in Lakhimpur district of Assam. The paper is an attempt to study the status of horticulture in Lakhimpur with special reference to Agricultural Development Office circles, Laluk and Narayanpur. The study looks into the factors that have contributed to the growth of horticulture in the two areas, as well as the problems that stand in the way of development of horticulture. An attempt has also been made to make a comparison of the two ADO circles. The study is based on observation and direct interview method. The data has been collected from primary as well as secondary sources. It has been found that there is disparity in the development of horticulture in the two areas. However, there is ample scope of horticulture to boost the economy of the areas.

Keywords: Horticulture, Development, Disparities, Government

INTRODUCTION

Horticulture is a science and an art of production, use, and enhancement of horticultural crops such as fruits, vegetables, spices, sauces, decorative, plantation, medicinal, and fragrant plants [1]. Horticulture is a combination of the Latin words "hortus", which means "garden"and, "cultura", which means "cultivation". Nearly 58% of India's population relies on agriculture and its related activities, including horticulture, as their main source of income [2]. Around 30% of the nation's total agricultural production is produced by the horticulture industry, which makes a significant contribution to the expansion of the agricultural sector in 2019-20. After China, India is the world's second-largest fruit and vegetable grower. The nation has become the world's top producer of tea, cashews,

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coconuts, and areca nuts [3]. With a share of 52.0% in total agricultural exports and 18.8% in total agricultural production, horticulture has become a well-known industry with a lot of potential for agricultural diversification [4]. Until recently horticulture was carried out as a non-commercial activity. but now it has emerge as an important sector of the state of Assam. Recent success in horticulture has promoted private investment. As it is a profitable activity, horticulture has transformed from a rural occupation to a commercial one that attracts young people to engage. The following crops and activities are covered under the horticulture sector in Assam. (1) Fruits (2) Vegetables (3) Spices (4) Floriculture (5) Potato (6) Onion (7) Medicinal & Aromatics (8) Mushroom cultivation (9) Fruits & vegetable preservation and processing (dirhorti.assam.gov.in, 2023). Important fruit crops of the state are- Banana, Pine apple, Assam lemon, Papaya, Orange, Guava, Litchi, Jack fruit and Mango.

But recently parts of Assam have started growing high value fruits like Dragon fruit, Strawberry, Passion fruit and Apple ber, seedless lemon in different parts of the state. Besides different fruit crops, tuber crops, spices, Kharif and Rabi vegetables that are grown in Assam. For unemployed youths, growing mushroom is considered s a lucrative farming endeavour. It is found that total area of rice is decreasing year by year in Assam. Area of rice in the year 2014-15 was 2495297 hectare [5] and it was decreased to 2360470 hectares in 2020-21[6]. The horticultural crop area of Assam is increasing gradually. It was 644397 hectares in 2014-15 [5] and increased to 663717 hectares in 2020-21 [6]. In Assam due to the state's diverse climate and soil numerous horticultural crops, including fruits, vegetables, spices, potatoes and other tropical tuber crops, mushrooms, ornamental, medicinal, and fragrant plants, plantation crops, cashews can be grown. About 15% of the state's gross cultivable area is dedicated to horticulture crops, which produce more than 76 lakh MT of various horticultural products each year [2]. In Assam there are up to 17 species, 53 varieties, and 7 hybrids of citrus. Mango species that are wild or semi-wild as well as temperate fruits, notably those from the Rosaceae family, are found in the state [7]. Lakhimpur district is located on the north bank of the River Brahmaputra in a remote area in North East India in the state of Assam. Lakhimpur has sub tropical humid climate with high rainfall. Average annual rainfall is about 2830 mm, temperature ranges from 8-35 degree Celsius and humidity is 74-89%. The location map of the study area is shown in fig 1.

 Lakhimpur's economy is primarily agriculture and is suitable for various types of horticultural crops due to its climatic condition. Due to its proximity to Arunachal Pradesh Lakhimpur get a market to sale the horticulture products and moreover there exists a favorable climate with required rainfall to grow horticultural crops in Lakhimpur. The horticulture crops covered in the area are fruits & vegetables. There are nine development blocks in the district. These are Narayanpur, Bihpuria, Karunabari, Nowboicha, Telahi, Lakhimpur, Boginodi, Ghilamora and Dhakuakhana Development Blocks. The study areas are Laluk ADO circle of Karunabari Block and Narayanpur ADO circle of Narayanpur Block of Lakhimpur District of Assam. In Laluk ADO circle seven farms from three villages namely Pachim Laluk, Harmoti and Merbeel are selected for the study. In Narayanpur ADO circle six farms from six villages namely Nimuri, Tatibahar, Rangoti, Bholabori, Madhupur, Bahupathar are selected which are shown in the figure 1. Selection of these two areas for the study is because of development differences and differences in the way of growing horticulture crops between these two areas.

OBJECTIVES
1. To examine horticulture farming in Lakhimpur district with special reference to Laluk and Narayanpur ADO circles.
2. To examine important factors that contributes to the growth of horticulture in these areas.
3. To find out difficulties faced by farmers to grow horticulture crops.
4. To make a comparison of the two regions regarding horticulture.

DATABASE AND METHODOLOGY
For the preparation of this paper, observation and direct interview methods are used. To prepare this paper seven horticulture farms in Laluk ADO circle and six farms in Narayanpur ADO circle are surveyed. To study about the various processes involved in production of horticulture crops, and the challenges faced by horticultural crop growers, observation and interview method have been used. The data has been collected from mainly two sources- primary sources and secondary sources. Primary data are collected by conducting field survey, direct interview and by observing the study area. Primary sources for the study are the horticultural crop growers, farm owners,

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employee of horticultural farms, government officers. And the secondary sources are government reports, research papers, journals, statistical handbook of Assam, District Agriculture Office, North Lakhimpur; Krishi Vigyan Kendra, Lakhimpur; ADO Office, Narayanpur.

RESULTS AND DISCUSSION

The major farming systems in Lakhimpur district are Agri-Horti-Animal Husbandry, Agri-Seri-Animal Husbandry, Agri-Fish-Animal Husbandry, Agri-Horti-Seri-Animal Husbandry-Fishery, Agri-Animal Husbandry [8]. The district Lakhimpur has a total geographic area of 2277 square kilometers. Around 9% of the district's gross cultivated area is covered by plantation and horticulture crops [9]. Various kinds of spices, fruits and vegetables has grown in the district. Areca nut, Banana, Coconut, Betel Vine and Assam Lemon are the important plantation and horticulture crops in the district. The high value crops like strawberry, dragon fruit, apple berry, seedless lemon, guava, mushroom etc. are also grown in the district. Around 11698 hectare area was covered by horticulture crops in the year 2019-20 in Lakhimpur district. And the total production was 827226 million tonnes in 2019-20 (District Agriculture Office, Lakhimpur). Among the nine blocks of Lakhimpur district, Laluk ADO circle of Karunabari block and Narayanpur ADO circle of Narayanpur block has been taken for the study. These regions have high potential for horticulture crops because of the excellent geographic location and climate. In these two areas the high value crops like strawberry, apple berry, dragon fruit, king chilli, mushroom, banana, seedless lemon etc. are grown. This study focuses on the analysis of various kinds of horticultural crops grown in the study areas, including production, the factors why horticulture crops are grown in the area, various issues related to the horticulture sector, and the role of government on the growth of the horticulture sector. This study will provide us a clear picture of the horticulture development and the scope of horticulture in the region.

Horticulture in Laluk ADO circle of Karunabari Block
The study area Laluk is situated along the Dikrong River in northern Assam, India, a very small municipality. It is around 35 miles southwest of North Lakhimpur city. Laluk ADO circle falls under Karunabari Block of Lakhimpur district of Assam. This circle is one of the highly developed horticulture area of the district. It has been possible due to government support to farmers to grow horticulture crops.

Variety of horticultural crops grown
The villages where the horticulture crops grown are Garmurh, Ratnapur, Torajuli, Ratnapur, Kutubpur, Fenkhati, Pndhuwa village [8]. Banana variety Amrit Sagar and G9, high yielding pumpkin variety Arjuna F-1, strawberry variety Sweet Charlie, Winter dawn and Early dawn, high yielding berry variety Apple ber, papaya variety Red lady, tomato variety Arka Rakshak and Roky (Check), brinjal variety PH-5, chilli variety G-4, potato variety Kufri jyoti, cabbage variety NSC-103 B, carrot variety Pusa Rudhira etc. are grown in the region [10]. Moreover among fruits thailand berry, dragon fruit, orange, Assam lemon; among kharif vegetables ridge gourd, sponge gourd, bitter gourd, bottle gourd and rabi vegetables like cabbage, cauliflower, carrot, knokhol, raddish etc. and among spices turmeric, ginger, black pepper etc. are grown.

Fertilizers use in Laluk ADO circle
Most of horticulture crops grown in the region using synthetic fertilizers by farmers. Organic fertilizers are also used by the farmers who grow horticulture crops in small patches of land. For growing tomato variety Arka Rakshak and Roky they use NPK in 150:70:140 kg/ha, for growing pumpkin variety Arjuna, use fertilizer: 75:80:80 NPK kg/ha. For growing different fruits and vegetables different amount of nitrogen fertilizer, phosphorus fertilizer, urea etc. are use by the farmers to enhance productivity. There are some reasons for of using synthetic or chemical fertilizers. These are availability of fertilizers at subsidized rate from government, quality of soil needs enrichment because of the previous practice of monoculture which left the soil infertile. Productivity is higher when synthetic fertilizers are used for high value crops like dragon fruit, strawberry, apple berry, etc.

Use of technology

Machineries like Ring cutter (ring like structure having curved blade attached) is use. It is used for harvesting of horticultural crop like brinjal and okra. Harvesting efficiency per hour manually is 28 kg but by using ring cutter it is 36 kg per hour. Availability of ring will cater to more market demands. Use of Pulverizer machine for grinding spices are mostly used for turmeric in this area. Other machineries like tractors, power tillers are used for growing horticulture crops. For irrigation, farmers use sprinkler and drip irrigation system successfully, which is provided under Pradhan Mantri Krishi Sinchayee Yojana (PMKSY). Farmers use sprinkler irrigation in the study area to irrigate leafy vegetables. To irrigate high value crops like straw berry, dragon fruit, citrus, and also for tomato, and king chilli, drip irrigation is used.

Other equipments available

Other equipments such as Poly house, Shade net, Mulching sheets are used. Poly houses are the most demanding type of greenhouse. Poly house technology is used for growing king chilli mostly and also used for growing strawberry. Shade net develops a suitable microclimate that is beneficial to the growth of the plants. Apple berries, strawberries and some vegetables like onions and tomatoes are grown under shade net in the study area by the farmers. Mulching is the technique of covering the top of the soil to prevent weed growth and keep the soil moist so that plants can grow. Mulching process is used for growing high value crop like strawberry.

Market

The output of horticultural products is sold in local market, Harmoti. The market is located 31 km towards west from district headquarters of North Lakhimpur. Most of the buyers are from nearer state Arunachal Pradesh. In Arunachal Pradesh there is a high demand for fruits like oranges, berries, bananas, straw berries and all types of vegetables. Due to the hilly terrain agricultural productivity is very low in Arunachal Pradesh and so, people come to buy agricultural products from Harmoti market. Some amount of horticultural output is also sold in Guwahati market and other parts of Assam. Some products are also exported to Arabian countries. Pumpkin, seedless lemon, Assam lemons are exported to Arabian countries.

Role of government in development of horticulture

Government of Assam has taken different initiatives for the development of horticulture in Laluk as it is an important area for horticulture development due to its proximity to the hilly state of Arunachal Pradesh, which provide favorable climate for the growth of horticultural crops. Government has provided fertilizers, pesticides, irrigation (sprinkler and drip), high yield seeds variety of fruits such as banana (Amrit Sagar and G9), pumpkin (Arjuna F-1), strawberry (Sweet Charlie, winter dawn and early dawn), brinjal (PH-5), chilli (G-4) and so on. Moreover government has provided training to farmers for spice production under the title of Management Practices of Black Pepper and Improved Cultivation Practices & Management of Ginger and Turmeric. Training is also given for strawberry production under the title of Scientific Cultivation and Management Practices of Strawberry. It is noted that the number of beneficiaries of government assistance in Laluk is quite high. So, the area has been able to make quite a progress in horticulture development.

Factors that contribute to the development of horticulture in Laluk ADO circle

Most important factor is the higher income or higher profitability. Farmers get more benefit by growing horticulture crops than cereals. Horticulture crops have very high demand in market. Another factor is the availability of market. There is a local market named as 'Harmoti market'. Most of the buyers from Arunachal Pradesh come to the market to buy fruits, vegetables and spices. Besides this, nearby people are also come to this market. Suitability of geo-climatic conditions is also one of the factors. Laluk ADO circle is suitable for horticulture due to its proximity to hilly state Arunachal Pradesh which provide favorable climate such as sufficient amount of rainfall and temperature required for horticulture. Government support to grow high value crops has helped the horticulture development in Laluk. The government contributes significantly to the growth of horticulture by giving farmers access to infrastructure, inputs and services. Some training about cultivation of exotic crops is also been provided.

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Problems faced by the farmers in Laluk region
The primary problem is the problem of processing. The success of cultivating fruits and vegetables is highly dependent on the presence of processing facilities. There is now no cold storage facility accessible, and there are no fruit processing facilities at all. Another set of urgent issues standing in the way of horticulture development is the scarcity of skilled or trained labour and insufficient extension support. Additionally, the majority of farmers are uneducated. Problem of pest attack and disease is also unavoidable. Attacks by pests, particularly those that target citrus trees, is one of the major issues that growers face and can result in significant losses. Citrus borer, fruit sucking moth, citrus butterfly, and fruit fly are the main attackers. Lack of training facilities hinders the growth of horticulture farms of small farmers. There are some small farmers aspiring to develop their own horticulture but they lack in skill due to lack of knowledge of scientific techniques of cultivation. Much more improvement will come in horticultural development in Laluk with the help of little scientific intervention in the area.

Horticulture in Narayanpur ADO circle of Narayanpur Block
The other area is Narayanpur. It is situated 54 km west of the district headquarters of North Lakhimpur. The greater Narayanpur area contains very fertile soil that is good for agricultural production. This land is best suited for growing crops like rice, lentil, and horticultural crops like potatoes, garlic, ginger, tomatoes, cauliflower, brinjal, and other vegetables. Different fruits including bananas, berries, mangoes, coconuts, guavas and many more are grown.

Variety of horticulture crops grown
Villages where horticultural crops are grown are Rangati, Madhupur, Kamalpur, Sesa Missing gaon, Pichola, Kachua, Major Chapori, Nimuri, Jalukota, Gobinpur village [8]. Most of the horticultural crops grown are of local variety. Some high value crops like strawberry variety (winter dawn, sweet Charlie), cabbage (NSC-103 B), pumpkin (Arjuna F-1) are grown by few farmers in the study area. Among fruits areca nut is dominant here (198 ha) followed by banana (151 ha) and least area is covered by thailand ber (6 ha only) other fruits such as coconut, pineapple etc. are also grown here. Among vegetables pumpkin is dominant here (136 ha), followed by cabbage (95 ha), ridge gourd (73 ha), tomato (45 ha) other vegetables such as cauliflower, carrot, knolkhol, bitter gourd etc are also grown. Spices such as turmeric (90 ha), ginger (83 ha), chilli (42 ha), garlic (35 ha) are also grown [11]. The fruits like dragon fruit, berry variety, Apple ber which are grown in Laluk ADO circle are yet to be introduced here.

Fertilizers use in Narayanpur
Most of the crops in Narayanpur are grown using organic fertilizers. Organic fertilizers used in the horticultural farms in Narayanpur ADO circle are obtained from agricultural wastes and livestock manures. Reason for using organic fertilizers is because of the rich quality of soil. Crops can be easily grown using organic fertilizers. Therefore requirement of synthetic fertilizer is less. Of course, another cause is that the farmers in the Narayanpur area are poor and don't have ability to buy fertilizers. Synthetic fertilizers are hardly provided by the government in Narayanpur ADO circle.

Use of technology
If we talk about machineries there is lack of availability of machineries required for growing and harvesting horticultural crops in Narayanpur. Most of the farm activities are done with the help of human labours and animals. However machineries like tractors, power tillers are used to perform activities like ploughing, tilling, sowing, and harrowing. Areca nut harvester is use for harvesting areca nut. In absence of rainfall farmers irrigate their farms with the help of bore well and installed by their own efforts. In some farms drip irrigation is installed by the government but have not been worked successfully. There is absence of sprinkler irrigation here.

Other equipments available
Equipment such as mulching sheets are used here. Most of the horticultural crop which require mulching are grown using organic mulch materials like plant grasses, leaves and woodchips in Narayanpur. Mulching sheets which are artificial or obtained from plastic or other equivalent materials are used by the farmers in the study area to grow strawberry. There is lack of facilities like poly house, shade net in horticultural farms in Narayanpur.

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Market

The agricultural outputs in the study area are sold in local market Bihpuria, located 34 Km south from the district headquarters North Lakhimpur. Some products are also sold in local Market Harmoti and Narayanpur. Harmoti market is about 23 km away from the study area. Only a few farmers send goods to Dubai, such as seedless lemons, however this practice has eventually been stopped due to inadequate transportation facilities.

Role of government in development of horticulture

Government has provided trainings to a few farmers for production of vegetables under the title of Commercial cultivation of summer vegetable in August 2020, for plantation crop- Scientific cultivation practices & management of Coconut and Areca nut etc. [8]. Nevertheless, most of the farmers are unaware about such trainings. There is also some help received in the form of HYV seeds, fertilizers, pesticides and irrigation facilities like drip irrigation etc. However, there is less number of beneficiaries of these benefits. Moreover Irrigation system does not work properly in most of the farms.

Factors contributing to the development of horticulture in Narayanpur

The horticulture crops fetch a higher income than other crops. Employment generation is another factor of horticulture development. Horticultural farms generate women employment in the study area as they are engaged in works like planting, plucking of fruits and vegetables in the horticulture farms. The soil and climate is good. Quality of soil is fertile in this area and so suitable for growing horticulture crops easily without using synthetic fertilizers.

Problems faced by the farmers in Narayanpur

The primary problem of the farmers is lack of marketing facilities. There is no organized marketing system. The producers encounter significant marketing challenges for practically all commodities, especially for selling products like seedless lemon, sweet lemon, ginger, guava etc. The farmers sell their produce to the middleman at throwaway prices because of the perishable nature of the goods and the lack of proper market support. Lack of processing units also creates difficulties. There is currently no cold storage facility available, and the complete lack of fruit processing facilities leads to tonnes of fruit being wasted. The success of horticulture crops depends on the use of appropriate pre and post harvest practices. There is lack of irrigation facilities in Narayanpur. Water scarcity of crops during the dry season, which lasts from October to February, is one of the major issues. The government provided drip irrigation system is not functional. Some crops, such as pineapple, banana, and green leafy vegetables, can produced year-round if there is proper irrigation system in place. Keeping intruders away from the crops is one of the problems that farmers have to deal with. Unfortunately, fences made of bamboo, wood does not persist for very long and begins to disintegrate after one year, and animals can easily enter to the farms.

Government schemes currently available in Laluk and Narayanpur ADO circles

Some important schemes are currently in operation for horticultural development in Laluk and Narayanpur. The Centrally Sponsored Schemes are

Rastriya Krishi Vikash Yojana: The Department of Agriculture & Cooperation (DAC), Ministry of Agriculture, Government of India, established the Rastriya Krishi Vikash Yojana (RKVY) in 2007-08 with the goal of achieving 4% annual growth in the agriculture sector.

Objectives

1. To ensure the preparation of agriculture plans for the districts and the states based on Agro-climatic conditions, availability of technology and natural resources.
2. To maximize returns to the farmers in agriculture and allied sectors.
3. To ensure that the local needs/crops/priorities are better reflected in the agricultural plans of the states.

Horticulture Mission for North-East and Himalayan States (HMNEH)
The Government of India, Ministry of Agriculture has implemented a centrally sponsored scheme, Horticulture Mission for North-East and Himalayan (HMNEH) States for overall development of horticulture.

Objectives
1. To improve the production and productivity of horticultural crops by harnessing the potential of the region.
2. Horticulture based farming system to be developed, thereby providing viable and ample opportunities for employment, especially for women, besides improving the productivity of land.

Pradhan Mantri Krishi Sinchayee Yojana (PMKSY)
It is a centrally sponsored scheme and was launched during the year 2015-16.

Objectives
1. Improving physical access to water on farms and increasing the cultivable area under assured irrigation.
2. Enhance the adaptation of precision-irrigation and other water saving technologies (More crops per drop).
3. Introduce sustainable water conservation practices.

However, in Laluk the beneficiaries of the above schemes are large in number compared to the Narayanpur.

Comparison of horticulture in Laluk and Narayanpur ADO circles
There are differences in how horticulture has developed in Laluk ADO circle of Karunabari block and Narayanpur ADO circle of Narayanpur block of Lakhimpur district. Although located in the same district, there are differences in crop variety, the utilization of technology, government support, and challenges faced by farmers. Compared to Narayanpur , Laluk is more advanced. Farmers in Laluk use technologies for horticulture farming. Moreover government support is more in Laluk than Narayanpur in terms of providing inputs like HYV seeds, synthetic fertilizers, irrigation, machineries and other services like trainings for horticulture development. On the other hand, horticulture is not much advanced in Narayanpur as compared to Laluk. There is less of use of technology like machines for ploughing, tilling, harvesting of horticultural crops. Tractors and power tillers used are less in number. There is absence of proper irrigation system in Narayanpur. They also use homemade organic fertilizers and not synthetic fertilizers as used in Laluk. Here the involvement of government is negligible for horticulture development. Government has provided drip irrigation facilities in the study area but they are not functional due to the ignorance of people involved in maintenance work. In Narayanpur, government schemes beneficiaries are less compared to Laluk. The farmers in Narayanpur are poorer and have not been able to avail themselves of technology or policies.

CONCLUSION

Lakhimpur district is suitable for growing horticultural crops due to its favorable climate. Both the study areas Laluk and Narayanpur ADO circle have immense scope for the development of horticulture but there are disparities between the study areas in terms of horticulture development. Laluk is more developed than the Narayanpur in terms of technology use in horticultural farms, irrigation facilities, government support for providing seeds, pesticides, and fertilizers. Horticulture in Narayanpur is done in a traditional way and is a technology deficit area. However, the common problems seen in both areas are lack of availability of processing units, unorganized market and irregular irrigation facilities. Of course horticulture is generating employment opportunities in both the study areas. Horticultural farm work, such as picking fruits and planting horticultural crops has also been a source of income for women. It has supported women financially. It is seen that given the geo-climatic conditions, there is also enormous scope in the Narayanpur ADO circle for sustainable horticulture development because production is possible with organic manures. A little help from the government in terms of training the small farmers and popularizing the schemes as well as setting up processing units will boost production in the study area.

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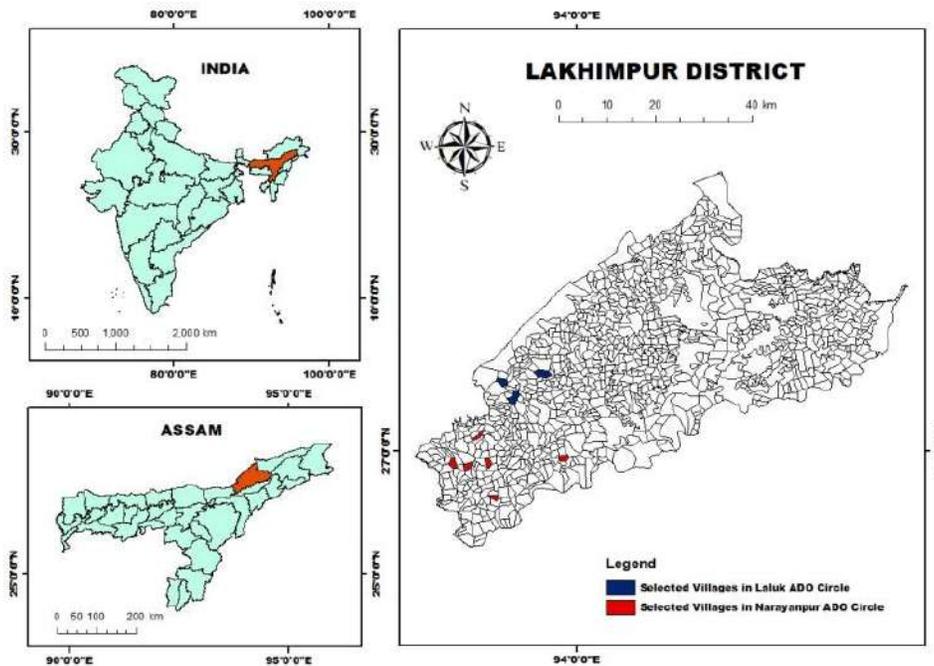
Fig .1 Map of the study area

RESEARCH ARTICLE

Reshaping the Indus Water Treaty in the Face of Technological Progress and Climate Variability

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ABSTRACT

The Indus Water Treaty, a historic agreement signed in 1960 between India and Pakistan, has long been a cornerstone of trans boundary water management. However, in the contemporary context characterized by rapid technological progress and the unpredictable impacts of climate variability, the treaty faces unprecedented challenges. This research delves into the intricate interplay between technology and climate change in reshaping the Indus Waters Treaty. The study examines the evolving dynamics of water resource management within the Indus River Basin, where advancements in technology have led to innovative monitoring systems, data analytics, and remote sensing tools. These technological interventions offer the potential to enhance the treaty's implementation and efficiency while addressing critical issues such as water scarcity, equitable distribution, and environmental sustainability. Climate variability poses a formidable threat to the delicate balance maintained by the treaty. Increasingly erratic weather patterns, glacial melt, and altered precipitation regimes necessitate adaptive strategies to safeguard the interests of both nations. This research explores how the treaty can adapt to the changing climatic conditions, incorporating resilience and flexibility into its framework. Through a multidisciplinary analysis, this study underscores the imperative for India and Pakistan to collaboratively embrace technology and adapt the Indus Waters Treaty to ensure the equitable and sustainable utilization of this vital water resource. The findings shed light on potential pathways for modernizing the treaty, fostering regional cooperation, and mitigating the challenges posed by technological progress and climate variability. Ultimately, this research aims to contribute to the broader

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discourse on trans boundary water governance in an era of rapid change and uncertainty (Thatte, C. D. 2018).

Keywords: Indus Waters Treaty, Technological Progress, Climate Variability, Remote Sensing, Trans boundary Water Governance.

INTRODUCTION

The Indus Water Treaty, signed in 1960, stands as a testament to international diplomacy's capacity to resolve complex issues. It delineated the allocation of water from the Indus River system between India and Pakistan, two nations sharing this vital resource. However, as we stand on the precipice of the third decade of the 21st century, the treaty faces challenges that were unforeseeable at its inception. Technological progress and the specter of climate change have reshaped the landscape of water resource management, necessitating a reassessment of the treaty's relevance and adaptability (Zawahri, N., & Michel, D. 2018). Technological advancements in the fields of hydrology, remote sensing, and data analytics have revolutionized water resource management. The Indus River Basin has not remained untouched by these innovations. Sophisticated monitoring systems, satellite imagery, and hydrological models have provided new tools for understanding the basin's hydrological dynamics. These technological interventions have the potential to enhance the treaty's implementation (Sharma, D. K. 2023). Real-time data sharing and analysis can facilitate better water resource management, enabling more equitable distribution and timely response to crises. Moreover, these tools can aid in resolving disputes and building trust between the signatory nations. One notable example is the use of remote sensing to monitor glacial melt in the Himalayas. As climate change accelerates glacial retreat, this technology can provide crucial data for adjusting water flow predictions, enabling proactive planning to mitigate downstream risks (Aijaz, A., et.al 2017).

Climate change, with its unpredictable consequences, poses a grave challenge to the Indus Waters Treaty. Increasingly erratic weather patterns, altered precipitation regimes, and shifting glacier dynamics threaten the delicate balance maintained by the treaty. The treaty did not anticipate the extent of climate change's impact on the basin. Changes in the timing and volume of water flows could disrupt established patterns of water allocation, leading to disputes and potentially exacerbating tensions between India and Pakistan (Alam, U. Z. 1998). One of the most pressing concerns is the potential for increased flooding and droughts. Climate models predict more extreme weather events, and the treaty's mechanisms for managing these events may prove inadequate in the face of such unpredictability. In this era of technological progress and climate uncertainty, adaptation is imperative. The Indus Waters Treaty must evolve to remain effective. It requires modernization to incorporate the benefits of technological advancements, improving data sharing and dispute resolution mechanisms. The treaty should incorporate climate resilience into its framework. This may involve a reevaluation of water allocation quotas (Qureshi, W. A. 2016) considering the long-term impacts of climate change on water availability. Flexibility and cooperation will be key to managing these challenges successfully. The Indus Waters Treaty is at a crossroads. Technological progress offers the potential for more efficient management and dispute resolution, while climate change threatens to disrupt established systems. To navigate these challenges successfully, India and Pakistan must come together to adapt and modernize the treaty. By doing so, they can ensure the equitable and sustainable utilization of the Indus River system for generations to come, demonstrating that even in the face of unprecedented challenges, diplomacy and cooperation remain potent tools for resolving complex issues.

OBJECTIVES OF THE STUDY

The main objectives of the study are multifaceted. Firstly, we aim to analyze the impact of advancements in hydroelectric technology since the 1960 signing of the treaty on dam construction and water management in the Indus River basin. Concurrently, we seek to explore how climate change has influenced water resources in the Indus basin and evaluate the treaty's ability to adapt to these shifting climatic conditions. Furthermore, we intend to investigate the economic losses and environmental costs incurred by India and other stakeholders due to the treaty's

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constraints on dam construction and operation. In addition, we will assess the political and diplomatic implications of potential revisions to the Indus Water Treaty, particularly regarding the incorporation of modern engineering practices and considerations related to climate change. As part of our study, we will propose recommendations aimed at modifying the treaty to align it with contemporary technological advancements, climate change realities, and the equitable distribution of water resources. Finally, we will emphasize the broader implications of adapting the Indus Waters Treaty for the management of trans boundary water resources in other regions that encounter similar challenges, there by contributing valuable insights to the field of international water resource management.

METHODOLOGY

The study adopts a descriptive and analytical qualitative research approach, primarily employing thematic analysis to identify trends and patterns. It heavily relies on secondary sources, including academic books, scholarly articles, and government of India reports, World Bank reports, and online website publications. These sources are meticulously examined to extract valuable insights into the subject matter, emphasizing the historical context, technological advancements, climate change impacts, economic and environmental costs, and political implications associated with the Indus Water Treaty. The thematic analysis framework helps in synthesizing and interpreting the information gleaned from these diverse sources, ultimately contributing to a comprehensive understanding of the treaty's past, present, and potential future adaptations within the broader context of transboundary water resource management.

Area of study
The study investigates the transformation of the Indus Water Treaty in response to technological advancements and changing climatic conditions, with a specific focus on its potential reshaping to address contemporary challenges in water resource management.

RESULT AND DISCUSSION

Revisiting the Indus Waters Treaty: Adapting to Modern Realities
The Indus Water Treaty, inked in Karachi on September 19, 1960, by then-Indian Prime Minister Jawaharlal Nehru and then-Pakistani President Ayub Khan, is a water allocation agreement facilitated and mediated by the World Bank. Its purpose is to allocate the available water resources of the Indus River and its tributaries between the two countries. This historic treaty resolved a longstanding water dispute between India and Pakistan when it was signed. However, as time has passed, it has become evident that advancements in technology have surpassed the original intentions and principles of the treaty. This underscores the urgency for both India and Pakistan to consider renegotiating the treaty, as permitted under Article XII (3). It is widely acknowledged that the technical expertise specified in the treaty has become outdated, and it is equally crucial to reevaluate the agreement in light of the impacts of climate change.

Water Dispute Background: The Involvement of the World Bank
Before India gained independence, water-related disputes were already present between the regions of Punjab and Sindh within unified India. After India and Pakistan became independent nations in 1947, this water dispute escalated into an international conflict. The issue of water allocation was officially raised with the governments of both India and Pakistan in 1948. Over the next four years, representatives from both countries engaged in discussions, yet they continued to hold steadfast to their respective positions (Qureshi, W. A. 2017). In May 1952, the World Bank, which had significant institutional and financial interests in both India and Pakistan, stepped in. The then-President of the World Bank, Eugene Black, offered the Bank's assistance in mediating the conflict. After extensive deliberations, the offer to mediate by the World Bank was accepted by both nations. Subsequently, negotiations continued, culminating in the signing of the Treaty on September 19, 1960. This Treaty was a unique

and groundbreaking agreement at that time, as it provided a peaceful framework for managing a precious natural resource for both emerging economies. According to the Treaty, the waters of the Eastern Rivers were made available for unrestricted use by India, while Pakistan was obligated to prevent any interference with the waters of the River Sutlej Main and the River Ravi Main in the reaches where these rivers flow within Pakistan but have not yet crossed into the country. In return, Pakistan was entitled to receive the waters of the Western rivers. India was granted limited use of the Indus, the Jhelum, and the Chenab Rivers for purposes such as domestic consumption, non-consumptive use, and agricultural needs as specified in Annex C of the Treaty, and hydroelectric power generation as outlined in Annexure D of the Treaty. Additionally, the Treaty addressed the engineering and legal complexities of the dispute through its eight annexure.

The Indus River Basin

The Indus River can be broadly divided into two primary tributaries: the river Kabul on the right bank and the river Panjnad (Panchnad) on the left bank. The river Panjnad is formed by the convergence of the river Jhelum and the River Chenab collectively referred to as the Western rivers in the Indus system. The River Panjnad (Baudouin, et.al 2020) eventually flows into the Arabian Sea south of Karachi. The Ravi, the Beas, and the Sutlej rivers are categorized as the Eastern Rivers. In India, significant tributaries of the Indus include the Jhelum, the Sutlej, the Chenab, the Ravi, the Beas, and the Ghaggar rivers. The Indus and Sutlej rivers originate in Tibet, while the others originate within India. Apart from these tributaries, the Kabul River, originating in Afghanistan, joins the River Indus in Pakistan. The outlets of the sub-basins are at Nimoo for the River Indus and Akhnoor for the River Chenab (Bolch, T. 2019).

Water Distribution Disparities

As per the Treaty's provisions, India was granted exclusive access to the waters of the Eastern rivers, estimated at 40.7 BCM (billion cubic meters) or 33 MAF (million acre-feet), while Pakistan was given full utilization rights over the Western rivers, estimated at 166.5 BCM or 135 MAF. Strikingly, India's allocation represents only approximately 19.6% of the total water share of the Indus river system through the Eastern Rivers, despite having almost double the catchment area in relation to this percentage. In contrast, Pakistan receives approximately 81% of the water share of the Indus system, with about half of its catchment area falling within Pakistan's boundaries. Recent assessments of water flow in the Indus basin among the riparian nations may differ from the values established in the 1960s. In the Indus River system, India contributes 50.86 BCM of water through the River Indus and the River Satluj, while Pakistan is allocated 186.48 BCM through the Western rivers (Sahni, H. K. 2006). According to Pakistani officials in 2019, they received 168.6 BCM in the Western rivers and an additional 6.04 BCM in the Eastern Rivers.

 Additionally, Pakistan also receives 33 BCM of water from Afghanistan. Consequently, Pakistan's total water allocation amounts to 207.2 BCM, out of which roughly 46.9 BCM is lost to the Arabian Sea due to inefficiencies within its water management system. This unequal distribution has led to Pakistan receiving an excessive share of water, despite its smaller catchment area. Conversely, on India's side, the states of Punjab, Haryana, and Rajasthan face acute water shortages. In the Indian state of Punjab, the net dynamic groundwater resources are 21.44 MCM (million cubic meters), while groundwater pumping reaches 31.16 MCM, resulting in an annual groundwater deficit of 9.72 MCM. The state is categorized as "over-exploited." Groundwater levels in most parts of Punjab have receded to more than 200 meters below the surface (Abas, N. et.al 2019). Out of Punjab's total land area of 5.03 million hectares, 4.32 million hectares are afflicted by a severe decline in groundwater levels. Similarly, the Indian state of Haryana, which was carved out of Punjab after the Treaty's signing, is also grappling with severe water stress. Rajasthan, where the Thar Desert is situated, receives only 83 mm of annual rainfall in the Jaisalmer district. Extensive areas in Rajasthan are covered by sand dunes, and numerous communities endure extreme temperatures exceeding 50 degrees Celsius. The availability of water for the growing population in the state is under severe strain (Akhtar, D. S. 2010).

Water Crisis in Indian States

Inefficiencies in agriculture, a deteriorating canal system, surface and groundwater pollution, soil contamination, and interstate disputes among Indian states continue to afflict the Indus Basin. Furthermore, the region faces the challenges of a rising population and declining per capita water availability (Begum, T. 2011). Punjab and Haryana, which account for approximately 4% of India's population, contribute 25% of the nation's total wheat production. Ensuring the water needs of these states is imperative not only for their economic and human development but also for guaranteeing food security for India's 1.4 billion people.

Technological Advancements in Hydroelectric Projects: Spillway Locations

The production of hydroelectric power from Western rivers in India remains a contentious issue within the context of the Treaty. Part 3, Annexure D of the Treaty permits India to establish new run-of-the-river hydroelectric plants. It specifies that if gated spillways are deemed necessary for such plants, the position of these gates in the "normally closed position" should be determined based on a balance between (Raza, K., & Adnan, M. 2023) sound and economical design and satisfactory construction and operation of works." However, it's crucial to acknowledge that the technology for constructing dams for hydroelectric projects has evolved significantly since 1960. In 1960, the concept of low-level sluice spillways in dams to facilitate the passage of entire flood discharges and the removal of sediments was non-existent due to limitations in hydraulic hoisting equipment for sluice gate operation. The Chenab and Indus rivers transport substantial sediment loads annually (Hafeez, S., et.al 2022). A reasonable interpretation of the Treaty implies that its stipulation for "sound and economical design and satisfactory construction and operation of works" should allow India to utilize contemporary and advanced technologies rather than obligating the construction of dams with "overflow spillways" at the top of the dam. The placement of these spillways plays a critical role in the reservoirs' long-term viability (Mustafa, D. 2010). Spillways positioned at the dam's uppermost section accelerate sedimentation, resulting in dam blockage within a few years of project commissioning. This leads to reduced peaking storage capacity and significant wear and tear of power-generating units, accompanied by operational and maintenance challenges. For instance, the dam of the Salal Hydroelectric Project on the Chenab River is already almost completely filled with sediment. Similarly, the dam of the Baglihar Hydroelectric Project on the Chenab River has faced a similar fate, with the reservoir almost filled to its upper limit. According to a study conducted by an International Consulting Company, (AC, M. S. 2005). Jammu and Kashmir has been deprived of approximately US $0.8 billion annually or INR 6,000 crores per year over the past five decades due to the restrictive clauses in the Treaty.

Pakistan's Dual Standards

Pakistan is currently constructing numerous major hydroelectric projects, such as Daimer Basha, Dasu, Mahl, Patrind, and Gulpur, on the River Indus and its tributaries, including areas in Pakistan-occupied Jammu & Kashmir. The Karot Hydroelectric Project became operational in 2022. These projects are designed to facilitate the passage of design floods and sediments through low-level sluice spillways, indicating that none of these projects rely on the technological expertise of the 1960s (Grumbine, R. et.al 2011). Consequently, it is unjustifiable for India to be confined by the technological standards of that era, as stipulated by the Treaty. The critical question that the World Bank must address is whether it will approve funding for a project anywhere in the world that utilizes technology involving overflow spillways on sediment-laden sluices dating back to the 1960s, as India is compelled to do. The Treaty fails to consider the consequences of rapid climate change on the environment. The governance framework of the Treaty lacks provisions for resilience against these risks. Given the urgent need to address climate change's likely impact on the Indus water basin, a modification of the Treaty is warranted (Sridharan, E. 2005).

Hydroelectric Advancements' Impact on Indus River Basin

Advancements in hydroelectric technology since the signing of the Indus Waters Treaty in 1960 have had a significant impact on dam construction and water management in the Indus River basin. One of the most notable advancements in hydroelectric technology has been in the efficiency of power generation. Modern turbines and generators are more efficient at converting water flow into electricity. As a result, new hydroelectric projects in the Indus basin can generate more electricity from the same amount of water, which is crucial for meeting growing

energy demands in the region (Ilyas, A., et.al 2022). The treaty originally favored the use of overflow spillways at the top of dams. However, advancements in dam engineering now allow for the construction of low-level sluice spillways. These spillways are more effective at managing floodwaters and sedimentation, as they can release water and sediments at lower levels, reducing the risk of sediment accumulation and damage to the dam's infrastructure. This innovation can extend the lifespan of dams and improve their overall effectiveness in water management (Azmat, M. 2015). Modern hydroelectric projects are equipped with advanced monitoring and control systems. These systems allow for real-time data collection and analysis, enabling dam operators to make more informed decisions about water release, reservoir levels, and power generation. This level of automation and control enhances water management efficiency and reduces the risk of operational errors. Advancements in hydroelectric technology have also led to a greater focus on environmental considerations. New dam designs often include fish-friendly features such as fish ladders or bypass channels to facilitate fish migration (Duncan, J., et.al 2012). Improved sediment management techniques help mitigates the ecological impact of sediment buildup in reservoirs. Climate change has brought about changes in precipitation patterns and water availability in the Indus basin. Advanced hydroelectric technology allows for more flexible and adaptive water management strategies. For instance, modern dam designs may include the ability to adjust water releases to respond to changing climate conditions, helping to ensure a more reliable water supply (Dinar, S., et.al 2015). The advancements in hydroelectric technology have transformed dam construction and water management in the Indus River basin. These advancements have improved the efficiency, safety, and environmental sustainability of hydroelectric projects. Embracing these innovations can help the region better cope with the challenges posed by increasing water demands, sedimentation, and the uncertainties associated with climate change. Revisiting the treaty to incorporate these technological advancements may be essential to ensuring equitable and sustainable water resource management in the Indus basin (Sharma, A. K., & Thakur, N. S. 2017).

Climate Change Impacts in the Indus Basin and Treaty Adaptability

The burgeoning impact of climate change on water resources in the Indus basin underscores the pressing need to evaluate the treaty's adaptability to these evolving climatic conditions. Notably, climate change has instigated discernible shifts in precipitation patterns across the Indus basin, manifesting as altered monsoon seasons, temporal and intensity variations in rainfall, and heightened precipitation variability. These transformations have direct repercussions on the accessibility and equitable distribution of water resources within the region. The Himalayan glaciers stand as pivotal contributors to the Indus River system's water supply. Escalating temperatures have expedited the process of glacial melting, (Michel, D. 2018) resulting in an initial surge in water flow. Paradoxically, this surge is projected to reverse as glacier volumes continue to dwindle, potentially culminating in diminished water availability over the long-term. This phenomenon constitutes a formidable challenge to the treaty's existing water allocation framework. The nexus between climate change and elevated temperatures has precipitated augmented water demands in sectors encompassing agriculture, industry, and domestic consumption.

This amplified demand exerts added stress on an already constrained water resource pool within the basin, accentuating existing challenges. Climate change's association with more frequent and severe extreme weather events, including floods and droughts, imparts further complexity to the landscape. Such climatic perturbations can disrupt the region's water management and infrastructure, thereby impacting the capacity to execute water control and allocation in accordance with the treaty's stipulations. The escalating sea levels introduce an additional dimension of concern. They have the potential to instigate saltwater intrusion into the coastal regions of the Indus delta, resulting in the salinization of freshwater sources. This further diminishes the already scarce pool of usable water resources within the basin, compounding the multifaceted challenges posed by climate change. In light of these intricate and interrelated climate-induced transformations in the Indus basin, a comprehensive evaluation of the treaty's adaptability to the evolving climatic milieu is not only prudent but imperative (Wolf, A. T. 2012). Effectively addressing the ramifications of climate change on water resources is essential to ensure the continued relevance and efficacy of the Indus Waters Treaty, facilitating equitable water allocation and sustainable management practices between India and Pakistan amidst a dynamically changing environmental backdrop.

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Assess the treaty's adaptability to these changing climatic conditions

The Indus Waters Treaty's fixed water allocation provisions may necessitate a reevaluation to introduce more flexibility and adaptability in response to the changing dynamics of water availability driven by climate change (Ringler, C. et.al 2014). One potential enhancement could involve incorporating mechanisms for periodic reassessment of water-sharing agreements, which would be guided by updated hydrological data, thereby bolstering the treaty's resilience in the face of shifting climate patterns. Furthermore, acknowledging the ecological consequences of climate change, the treaty could be amended to include provisions geared toward safeguarding ecosystems impacted by fluctuating water flows (De Stefano, et.al 2012). These provisions might encompass the establishment of environmental flow requirements aimed at preserving the overall health of the rivers within the basin. In light of the heightened risk of extreme weather events associated with climate change, the treaty could also encompass provisions for coordinated disaster preparedness and response between India and Pakistan. Such provisions would aim to mitigate the devastating effects of floods and droughts, fostering cooperation in managing climate-induced emergencies. Moreover, recognizing the influence of glacial melt water on heightened sediment transport in rivers, the treaty could explore the implications for hydropower generation and sediment management in dams (Dinar, S., et.al 2015). To ensure the treaty remains adaptive to changing conditions, its governance mechanisms may require regular reviews and updates informed by the latest climate data and scientific assessments. Climate change presents significant challenges to the water resources of the Indus basin. To uphold the treaty's enduring relevance and effectiveness, adapting its provisions to address climate change impacts, (Yaqoob, A. S. M. A. 2015) promote sustainable water management, and ensure equitable water allocation between India and Pakistan amidst evolving climatic conditions may be of paramount importance.

Economic and Environmental Costs of Treaty-Imposed Dam Constraints

Investigating the potential economic losses and environmental costs incurred by India and other stakeholders due to the treaty's constraints on dam construction and operation reveals several key considerations. The treaty imposes restrictions on India's ability to fully utilize the Western rivers for hydroelectric power generation, potentially resulting in economic losses related to unrealized electricity production. The extent of these losses depends on the number and capacity of affected hydroelectric projects. India's substantial energy needs may lead to increased reliance on fossil fuels like coal and natural gas to meet electricity demand, resulting in economic and environmental costs associated with higher greenhouse gas emissions. The treaty's allocation of water resources can exacerbate water scarcity in states such as Punjab, Haryana, and Rajasthan, impacting agricultural productivity and food security, thereby incurring economic losses in the agriculture sector. The constraints on dam construction and operation, including the use of overflow spillways, can contribute to environmental degradation (Lutz, A. F et.al 2016) through sedimentation, affecting reservoir storage capacity and requiring costly dredging operations. Alterations in river flows can also impact aquatic ecosystems and biodiversity, incurring environmental costs.

Fifthly, ongoing maintenance costs for infrastructure affected by sedimentation and wear and tear due to overflow spillways can result in economic expenditures. The treaty's constraints may intensify water stress in certain regions, leading to economic losses stemming from conflicts over water allocation and the need for water management measures (Zawahri, N., & Michel, D. 2018). The stakeholders may need to invest in environmental compensation measures, such as habitat restoration or water quality improvement projects, to mitigate the environmental impacts of dams and reservoirs, incurring associated economic costs. Legal disputes between India and Pakistan regarding treaty compliance and water sharing can lead to economic losses due to legal fees and diplomatic efforts to resolve disputes. Quantifying the precise economic losses and environmental costs necessitates a comprehensive assessment considering factors like the number and size of impacted dams, sedimentation levels (Nax, N. A. 2016) agricultural consequences, and environmental impacts. Such assessments typically involve interdisciplinary research and collaboration among experts in economics, environmental science, and engineering.

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Political and Diplomatic Implications of Modernizing the Indus Waters Treaty

Assessing the political and diplomatic implications of revising the Indus Waters Treaty to incorporate modern engineering practices and accommodate climate change considerations involves a multifaceted analysis. The Indus Waters Treaty has served as a cornerstone of India-Pakistan relations for decades, and any proposed revisions to the treaty would necessitate delicate negotiations and diplomatic efforts. The political climate and the willingness of both countries to engage in such negotiations will be of paramount importance. The process could potentially strain diplomatic relations if not managed with utmost care (Qureshi, W. A. 2021). Revising the treaty demands a high level of mutual trust between India and Pakistan. Both parties must have confidence that the proposed changes will be mutually beneficial, and that each side will faithfully adhere to the revised terms. Establishing trust-building measures will be essential to create an environment conducive to successful negotiations. Given the historical role of the World Bank in mediating the original treaty, there may be an opportunity for international mediation to facilitate discussions on revisions. However, this could introduce additional complexities, as the interests and influence of international actors must be considered. The Indus River basin holds critical importance for regional stability. Any disruptions or disputes that may arise from treaty negotiations could have broader implications for the stability of neighboring countries in the region. It may be necessary to consult with regional stakeholders to mitigate such risks. Water is a fundamental security issue, and any alterations to the treaty could be perceived as a threat to national water security by either India or Pakistan (Ali, S. S., et.al 2021) Striking a balance between the legitimate water needs of both countries while effectively addressing modern challenges such as climate change presents a nuanced and politically sensitive challenge. In both India and Pakistan, domestic political considerations can exert influence on decisions related to the treaty. Political leaders may encounter pressure from domestic constituencies, especially those in water-scarce regions, who may harbor concerns regarding treaty revisions affecting water availability.

Incorporating climate change considerations into the treaty may entail adjustments in water allocation that could potentially impact downstream regions and ecosystems (Magsig, B. O. 2017) Effectively addressing these environmental concerns while preserving political goodwill presents a formidable diplomatic challenge. The revision process would necessitate a profound understanding of the legal, technical, and engineering aspects associated with water management. Access to experts and the ability to navigate intricate technical discussions would prove indispensable for the success of negotiations. Any revisions introduced to the treaty should be grounded in a long-term commitment to cooperation (Rao, S. 2017). Climate change impacts and technological advancements will persistently evolve, and the treaty should demonstrate adaptability to changing conditions over time. Revising the Indus Waters Treaty to encompass modern engineering practices and climate change considerations constitutes a complex undertaking rife with significant political and diplomatic implications. It would demand a delicate balancing act, encompassing trust-building initiatives, regional stability considerations (Adeel, Z., et.al 2016) and the acknowledgment of each country's water security concerns. Engaging in such a process would necessitate a high level of political determination and diplomatic finesse to ensure a mutually beneficial outcome.

Trans boundary Water Management Lessons from Indus Treaty

The process of adapting the Indus Waters Treaty to address contemporary challenges carries profound implications for the management of trans boundary water resources in regions confronting analogous issues. Its successful adaptation can serve as an instructive model for other regions grappling with trans boundary water disputes. It exemplifies that, (Qaddumi, H. 2008) even in politically sensitive contexts, countries can prevent conflicts over shared water resources through diplomacy, cooperation, and forward-thinking agreements. Climate change, a global challenge affecting water availability and quality in numerous regions, underscores the treaty's relevance. Its adaptation to climate change realities sets an influential precedent for trans boundary water agreements worldwide. By incorporating climate resilience measures, it demonstrates how countries can adapt to changing hydrological conditions while maintaining cooperation (Susskind, L. 2018). The treaty's emphasis on environmental conservation and ecosystem protection establishes a noteworthy precedent, recognizing the ecological significance of shared river systems. Other regions can draw from these provisions to develop their own agreements, striking a balance between water use and environmental sustainability. The integration of modern engineering practices in dam construction and operation, a core aspect of the treaty's adaptation, has the potential to inspire innovation in similar contexts.

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Sharing knowledge about improved water management technologies can greatly benefit countries confronting analogous challenges in optimizing their water resources. Robust mechanisms for data sharing and transparency foster trust among riparian states. Such trust-building measures can be leveraged in other regions to encourage cooperation and information exchange, ultimately enhancing water management practices. The treaty's dispute resolution mechanisms offer valuable lessons in peaceful conflict resolution concerning trans boundary water disputes (Kamran, et.al, 2017). These experiences can be applied in other regions to develop effective mechanisms for addressing disagreements over shared water resources. The involvement of local communities and stakeholders in decision-making processes highlights the importance of considering the interests and concerns of those directly impacted by water management decisions. Similar participatory approaches can be embraced in other regions to ensure comprehensive and inclusive decision-making. Investment in capacity building and knowledge-sharing initiatives, a notable feature of the treaty's adaptation, can be replicated elsewhere to ensure that countries possess the technical expertise required for effective shared water resource management. Exploring the utilization of international organizations or third-party mediators as facilitators in treaty negotiations can be considered in other regions as a means of resolving disputes and (Choudhury, E. 2017) promoting cooperation. Promoting public awareness and education about responsible water management can foster a culture of water conservation and cooperation in regions grappling with analogous challenges. The adaptation of the Indus Waters Treaty offers a wealth of insights and best practices for the global management of trans boundary water resources. It underscores the potential for diplomacy and collaborative agreements to address complex water-related challenges and promote sustainable, equitable, and peaceful water management in regions characterized by shared river systems.

Looking Forward: Reconsidering the Treaty

As we cast our gaze into the future, it becomes evident that the circumstances that surrounded the Treaty's ratification 63 years ago are no longer relevant. The Treaty must now acknowledge the new realities faced by India, an emerging economy with the world's largest population, heavily reliant on monsoons and agriculture, and facing substantial climate change-related risks and sedimentation challenges. India's ability to effectively address climate change is not only crucial for its vast population but also for the well-being of humanity as a whole (Bhatnagar, M. 2008). These factors must be taken into serious consideration if the Treaty is to remain relevant, sustainable, and equitable for the people of the Indian subcontinent. In accordance with contemporary engineering standards, India should have the flexibility to construct hydroelectric projects that incorporate low-level sluice spillways. This necessitates the establishment of a new framework. Such a revision is essential not only to address the annual losses incurred by India due to dam damage but also to ensure the survival of the Treaty by adapting to the evolving parameters and advancements in technological expertise, thus promoting both fairness and sustainability (Saad, M., et.al 2018).

Major Findings

1. The study reveals that advancements in hydroelectric technology since the treaty's signing in 1960 have significantly impacted dam construction practices in the Indus River basin.
2. Climate change has emerged as a major driver of change in the Indus basin, leading to shifting precipitation patterns, glacial melting, and increased water demand due to higher temperatures.
3. The treaty's allocation of water resources, although equitable in its time, has led to a situation where Pakistan receives a disproportionate share of water compared to India, which has led to water scarcity issues in certain Indian states.
4. The study highlights significant economic losses incurred by India and other stakeholders due to the treaty's constraints on dam construction and operation, including unrealized hydroelectric power generation, increased reliance on fossil fuels, and agricultural productivity impacts.
5. The treaty's provisions, such as overflow spillways, have led to environmental degradation, including sedimentation in reservoirs, alterations in river flows, and aquatic ecosystem impacts, resulting in additional environmental costs.

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6. The study emphasizes the need for the treaty to adapt to climate change realities, such as glacial meltwater contributions and increased frequency of extreme weather events.
7. Successfully revising the treaty requires trust-building measures between India and Pakistan, considering the historically sensitive nature of water disputes in the region.
8. The World Bank's involvement in mediating the original treaty suggests the potential for international mediation to facilitate discussions on revisions. However, this introduces additional complexities.
9. Any disruptions or disputes arising from treaty negotiations could have broader implications for regional stability, potentially affecting neighboring countries and stakeholders.
10. Water is viewed as a fundamental security issue, and changes to the treaty could be perceived as a threat to national water security by either India or Pakistan.
11. The study underscores the importance of deep technical expertise in water management and the need for access to experts in dam construction and operation.
12. Any revisions made to the treaty should be based on a long-term commitment to cooperation, ensuring that the treaty remains adaptable to evolving climate conditions and technological advancements.

Recommendations for Modernizing Indus Waters Treaty
Proposing recommendations for modifying the Indus Waters Treaty to align with contemporary technological advancements, climate change realities, and equitable water distribution involves a comprehensive approach that addresses the challenges and opportunities presented by the evolving context. Here are some key recommendations:

1. Establish a mechanism for periodic reviews of the treaty, considering the latest hydrological data and climate change projections. This will ensure that the treaty remains adaptable to changing conditions over time.
2. Integrate climate change considerations into the treaty, recognizing the impact of changing precipitation patterns, glacial melt, and extreme weather events on water resources. Develop provisions that allow for adaptive water management strategies in response to climate variability.
3. Update the treaty to allow for the use of modern dam construction and operation practices, including low-level sluice spillways, which are more effective in managing sedimentation and floodwaters. This can extend the lifespan of dams and improve their overall efficiency.
4. Include provisions for the protection and restoration of ecosystems affected by dam construction and operation. Establish environmental flow requirements to maintain the health of river systems and aquatic habitats.
5. Enhance data-sharing mechanisms between India and Pakistan, promoting transparency in water-related information. Develop a joint platform for real-time data exchange to facilitate better water management decisions.
6. Promote cooperative water management practices that prioritize equitable water distribution and minimize disputes. Encourage joint initiatives for water conservation, efficient irrigation practices, and sustainable agriculture.
7. Strengthen the dispute resolution mechanisms within the treaty to expedite the resolution of water-related conflicts through diplomatic means. Consider involving impartial third-party mediators when necessary.
8. Mandate comprehensive environmental impact assessments for all new dam projects, considering their potential ecological consequences and long-term sustainability.
9. Address the impact of sedimentation on hydropower generation and incorporate solutions to manage sediments effectively. Explore opportunities for joint hydropower projects that benefit both countries.
10. Involve local communities and stakeholders in decision-making processes related to water management and dam construction. Recognize their rights and concerns in the treaty provisions.
11. Develop strategies for effective drought and flood management, considering the increasing frequency of extreme weather events associated with climate change.
12. Invest in capacity building and knowledge-sharing initiatives to ensure that both India and Pakistan have the technical expertise to implement the treaty's provisions effectively.
13. Consider the role of international organizations or third-party mediators in facilitating discussions and resolving disputes when bilateral negotiations reach an impasse

14. Promote public awareness and education campaigns to inform the citizens of both countries about the importance of water conservation, equitable water sharing, and the benefits of a revised treaty
15. Ensure that any modifications to the treaty reflect a long-term commitment to cooperation and equitable water distribution, taking into account the interests and needs of both India and Pakistan.

CONCLUSION

The Indus Water Treaty, while a landmark agreement in water sharing between India and Pakistan, is facing unprecedented challenges in the modern era characterized by rapid technological progress and increasing climate variability. The evolution of these two critical factors necessitates a thoughtful and proactive approach to reshape the treaty to ensure its continued effectiveness in managing the shared Indus River basin. Technological progress has significantly altered the way water resources are managed and monitored. Remote sensing, data analytics, and Geographic Information Systems (GIS) have revolutionized our ability to track water flow, precipitation patterns, and glacial melt in near-real-time. Incorporating these technologies into the treaty framework can provide both India and Pakistan with more accurate and timely data to inform their water management decisions. By creating a joint technical committee responsible for integrating these tools, the treaty can adapt to the 21st-century realities and enhance transparency and trust between the parties. Climate variability poses a substantial threat to the sustainability of the Indus River basin. The region is experiencing shifting weather patterns, erratic monsoons, and the accelerating retreat of glaciers in the Himalayas.

These changes have the potential to disrupt the delicate water balance established by the treaty. To address this, the treaty should include provisions for adaptive management, allowing the parties to respond flexibly to changing climate conditions. Furthermore, it may be necessary to establish a mechanism for sharing the burden of climate adaptation measures and infrastructure investments to mitigate the impact of climate change on water resources. Moreover, fostering greater cooperation and people-to-people exchanges between India and Pakistan can contribute to mutual trust and understanding. Water diplomacy should extend beyond the government level to include civil society, academia, and non-governmental organizations, fostering a broader sense of ownership and shared responsibility for the sustainable management of the Indus River. The Indus Waters Treaty is at a critical juncture, where the convergence of technological progress and climate variability demands a recalibration of its mechanisms. While the core principles of the treaty remain sound, its operational aspects require modernization to meet contemporary challenges. Through the integration of advanced technology, adaptive management strategies, and enhanced cooperation, India and Pakistan can ensure the equitable and sustainable utilization of the Indus River's waters, safeguarding the livelihoods and well-being of millions of people dependent on this vital resource. The urgency of reshaping the treaty cannot be overstated, as it holds the key to regional stability, environmental sustainability, and the prosperity of the Indus River basin for generations to come.

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RESEARCH ARTICLE

Structural Analysis of GO based Cobalt Oxide Core Coated with Silica Shell Nano particles Characterization and their Electrochemical Application

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ABSTRACT

The Co_3O_4 core, SiO_2 shell, and over coated GO sheet are the topics of this work. These core shells' biosynthetic methods, opto-structural characteristics, and super capacitor function have been described. The qualities both with and without coating were thoroughly examined. The absorbance and transmittance have also been described by the optical characterization methodologies for GO based Co_3O_4 core and SiO_2 coated shell nano particles. By using XRD and FTIR, their physical characteristics have been designed. Cyclic voltammetry was used to examine the capacitance behavior of Co_3O_4 core and SiO_2 coated shell nano particles based on GO. With an emphasis on their applications, the potential of such GO-based Co_3O_4 core and SiO_2 coated shell nano particles is highlighted.

Keywords: GO sheet, core shell, Biosynthesis, physical characterization and impedance.

INTRODUCTION

Recently, a number of physical and chemically based methods have been used to produce the diverse Co_3O_4 nanostructures and improve their theoretical specific potential and electrochemical capacity. Due to its low potential or energy density and poor cycling stability, research on novel cobalt oxide composite materials for super capacitors has been thoroughly analyzed [1]. Precipitation, sol-gel combustion, thermal decomposition, chemical vapor deposition, wet polymerization, laser ablation, solvo thermal procedures, micro-emulsion, and hydrothermal techniques are some examples of these. In addition to these conventional synthesis procedures, green synthesis techniques provide a number of advantages, including cost effectiveness, a lack of need for extra chemicals, and environmentally friendly practices with little waste production [2]. These Co_3O_4 nano particles are employed in human immunization adjuvants, magnetic resonance contrast agents, medication delivery systems, and as adjuvants. The synthesis of core/shell structured materials provides the supporting behavior between the core and shell materials. The primary benefits of nanostructure materials increased by a SiO_2 core shell are superior environmental stability and material compatibility [3]. Because silica materials offer excellent physical, chemical, mechanical, and optical properties, they are frequently used in high-tech applications. The peculiar optical properties of SiO_2 nanoparticles revealed at the nano scale have been determined to be caused by surface flaws.

Silica nano particles have undergone substantial investigation to determine the size-dependent physicochemical features and specific optical characteristics at lower sizes. Due to the increase in optical fluorescence intensity for stilbene 420 in mesoporous silica nanoparticles, these nano materials would be more advantageous for the usage of nano sensors and nanolasers [4]. Graphene, a notably one atom-thick carbon substance, is a current favorite for developing functional modified materials. Graphene is regarded as a possible candidate for a wide range of applications in many technological disciplines, including nano electronics, composites, energy storage devices, effective lasers, photo detectors, and biological applications, because of its exceptional physical and chemical properties [5]. Metal salt, a reducing agent, and a stabilizing agent are three crucial requirements for the metallic nanoparticles that are biosynthesized using plant extract in order to regulate the size of the particles and prevent their aggregation. Bioreduction, synthesis, and stability of metal nano particles may involve bio molecules such proteins and enzymes, amino acids, carbohydrates, alkaloids, terpenoids, tannins, saponins, phenolic compounds, reducing sugar, and vitamins. The amount of nanoparticle synthesis is significantly impacted by the ion reduction potential and the capacity of plants to reduce when poly phenols, enzymes, and other chelating agents are present [6]. In this study, the Co_3O_4/SiO_2 core shell was made using an environmentally benign synthesis method and a natural extract of Aristolochia indica. Analysis was done on the physical, optical characterization, and capacitance behavior of Co_3O_4 core and SiO_2 coated shell GO based nano particles.

PREPARATION OF $Co_3O_4/SiO_2/GO$ CORE SHELL

The Aristolochia Indica plant's dried stem weighed 20 g. Then, 100 ml of distilled water was added, and it was heated at 55 °C for 10 minutes. The solution turned from translucent to a light yellowish color. The resulting extract was filtered using What man No. 1 filter paper, and the filtrate was then collected in a 250 ml Erlenmeyer flask. The 0.5M cobalt carbonate solution was incorporated with 20 ml of dried Aristolochia Indica stem extract, and the combination was constantly stirred at 60 °C for 15 minutes. The mixture was continually swirled for 90 minutes. The outcome was a precipitate with a light purple color that was washed five times in distilled water and ethanol. The precipitate was also dried for 11 hours at 100 °C. At 360 °C, the resulting Co_3O_4 nano powder was calcined. Eventually, black Co_3O_4 nano powder was obtained and used for further investigation. Aristolochia Indica dried stem extract (20 ml) and a 0.5 M cobalt carbonate solution were combined, and the mixture was constantly stirred at 60 °C for 15 minutes. The mixture was vigorously stirred for the full 90 minutes. A light purple precipitate was the end product, and it was washed five times in distilled water and ethanol. Additionally, the precipitate was dried for 11 hours at 100 °C. A 360 °C calcination process was used to produce Co_3O_4 nano powder. The black Co_3O_4 nano powder was eventually collected and used for further investigation. For the $Co_3O_4/SiO_2/GO$ nano composite, 20 mL of a GO aqueous suspension (1.0 mg/mL) was mixed with 0.6 mg of Co_3O_4/SiO_2, and the resultant solution was aged for 30 min. Once more, add 10 mL of Aristolochia Indica extract drop wise to the prepared solution and stir

continuously for 90 minutes at room temperature. After that, the resulting solution was decanted, and an oven was used to dry the $Co_3O_4/SiO_2/GO$ core-shell at 100 °C for 24 hours. Finally, a black $Co_3O_4/SiO_2/GO$ core shell was gathered and employed for additional research.

RESULT AND DISCUSSION

X-ray Diffracto gram Analysis
The crystalline and phase structures of the eco-friendly Co_3O_4 core and SiO_2-coated shell nanoparticles were investigated using XRD analysis (Figure 1). In the diffraction of the core Co_3O_4, peaks at 2θ = 31.4°, 36.98°, 44.9°, 55.8°, 59.4°, and 65.4° were observed. These peaks matched the planes of the PCPDF No. 653103 at (220), (311), (400), (422), (511) and (440). An intense peak at 2θ for the core-shell $Co3O4/SiO_2$ corresponds to the (111), (220), (311), (400), (003), (022), (511) and (440) planes matched with JCPDS No:421467, and is 19.2°, 31.6°, 37.2°, 45°, 50.7°, 55.6°, 59.8°, and 65.6°, respectively [7-9]. Peaks at 2θ were seen when GO was introduced to the Co_3O_4/SiO_2 core shell. These peaks correspond to the (111), (002), (011), (003), and (022) designs of the GO-based cobalt core encased in silicon. They were 18.5°, 26.2°, 26.6°, 29.1°, 33.8°, 35.7°, 45.9°, and 54.8°. [10]. The Debye-Scherrer formula was used to determine the average particle size in the peak locations.

$$D = 0.9\lambda / \beta\cos\theta \tag{1}$$

Where β is full width at half maximum (FWHM), θ is the diffraction angle, and λ = 1.5418 (X-Ray wavelength). Table 1 shows the typical size of the core and core-shell. Inner atomic gap refers to the separation between the parallel atomic planes. The high-intensity diffraction angle (θ) is used to Calculate it. The length of dislocation lines per unit surface area, often known as the dislocation density, is calculated by

$$\delta = \frac{1}{D^2} \tag{2}$$

Where D is the particle size in nm and δ is the dislocation density. It can be seen in figure 2. Table 1 contains a summary of these values. The following relation was used to determine the microstrain of the GO-based Co_3O_4 core covered with SiO_2:

$$\varepsilon_{micro} = \beta\cos\theta / 4 \tag{3}$$

Where β indicates for full width at half maximum (FWHM), micro strain stands for ε_{micro}, and θ is the diffraction angle. The following equation was used to determine the stacking defect of the Co_3O_4 core made of GO and covered in a SiO_2 shell

$$SF = \frac{2\pi^2}{45\sqrt{3}\tan\theta} \tag{4}$$

Where the stacking fault is SF. The following formula was used to compute the X-ray density:

$$\rho_x = \frac{ZM}{N_a a^3} \tag{5}$$

Where a is the volume, NA is Avogadro's number, M is the molecular mass, and ρx is the X-ray density. These values were displayed in table 1. Figure 2 illustrate the dislocation densities of the prepared core Co_3O_4, core shell SiO_2 and $Co_3O_4/SiO_2/GO$. From the figure 2, the dislocation density increased with decreasing the crystalline size. The developments of dislocations were obstructed by additional dislocations present in the prepared GO based Co_3O_4 core coated with SiO_2 shell. A more dislocation density implicit a more rigidity of the core shells [11].

Functional Group Analysis
The FT-IR spectra of a GO-based Co_3O_4 core coated with shell SiO_2 nano particles in the range of 4000 to 400 cm⁻¹ are shown in the peaks of Figure 3. The broad band at 3422 cm⁻¹ and 3417 cm⁻¹, the absorption at 2922 cm⁻¹ to 2853 cm⁻¹

due to the stretching vibration of C-H alkanes, and the peak at 1620 cm^{-1}, 1638 cm^{-1}, and 1617 cm^{-1} are all attributed to the O-H stretching and bending modes of water in the peak of CO_3O_4. The stretching vibration of the C=O bond causes the weak absorption peaks at 1121 cm^{-1}, 1126 cm^{-1}, 1115 cm^{-1}, 1021 cm^{-1}, and 1020 cm^{-1}, whereas the high absorption peaks at 618 cm^{-1}, 662 cm^{-1}, and 623 cm^{-1} are caused by the stretching vibration of the metallic oxygen bond in the Co-O band. Co^{2+}, Co^{3+}, and O^{3-} is given accept for this band. The stretching and bending vibrations of the silicon-oxygen bond are related to the prominent bands at 466 cm^{-1}, 416 cm^{-1}, 467 cm^{-1}, 565 cm^{-1}, and 540 cm^{-1}. Force constant had a linear impact on the bond length between metal and oxygen ions and the change in absorption band frequency that was related to the A sited and B sites [12]. Furthermore, Tetrahedral Co_3O_4, Co_3O_4/SiO_2, and $Co_3O_4/SiO_2/GO$ core shells have force constants of 1.72×10^{-2} Nm^{-1}, 2.9×10^{-2} Nm^{-1}, and 3×10^{-2} Nm^{-1}, respectively. The force constants for Co_3O_4, Co_3O_4/SiO_2, and $Co_3O_4/SiO_2/GO$ core shells, are 1.272×10^{-2} Nm^{-1}, 1.872×10^{-2} Nm^{-1}, and 272×10^{-2} Nm^{-1} respectively. As the amount of SiO_2 and GO in the coating grows, so does the material's force constant. The findings revealed that the coating materials SiO_2 and GO had an impact on force constant increases [12].

Impedance spectroscopy analysis

The most crucial method for examining the electrical response and material transport characteristics is impedance spectroscopy. In general, it is possible to assess the contribution of the nano particle's grain, grain boundary, and electrode effect over a wide range of frequencies at room temperature. Typically, the complex dielectric constant ($\mathcal{E}^*$) complex impedance (Z^*), electric modulus (M^*), and loss tangent (tan) are used to describe a material's electrical properties. It is possible to compute and relate these variables to one another. It is possible to write the computation that determines the complex impedance (Z^*) as [14].

$$Z^* = Z' + jZ'' \tag{6}$$

SiO_2 and GO coatings increase the internal resistance of core shell Co_3O_4/SiO_2 and core shell $Co_3O_4/SiO_2/GO$ in comparison to core Co_3O_4. The charge controlled zone is represented by a single semicircle in the high frequency band of each curve, giving the impression that they are all similar. However, despite the curves appearing to be identical in terms of their forms, they actually differ considerably in terms of size [15]. This indicates that while each sample's effective area will vary, the same fundamental processes must be at work on all of these coatings (Figure 4). The semicircle typically reflects the grain boundary contribution at intermediate frequencies and the electrode impact at higher and lower frequencies, respectively. When SiO_2 and GO are added to the Co_3O_4 core, the values of Z' at low frequencies fall, mimicking the behavior of semiconductors [13]. The complex impedance spectrum of core Co_3O_4, core shell Co_3O_4/SiO_2, and core $Co_3O_4/SiO_2/GO$ at room temperature is depicted in Figure 4 over a broad frequency range. The semicircle typically reflects the grain boundary contribution at intermediate frequencies and the electrode impact at higher and lower frequencies, respectively.

CONCLUSIONS

Co_3O_4 core, Co_3O_4/SiO_2, and $Co_3O_4/SiO_2/GO$ nano powders were successfully synthesized employing aqueous extracts from *Aristolochia indica* as an efficient biosynthesis agent. The creation of pure, crystalline Co_3O_4 core and Co_3O_4/SiO_2 and $Co_3O_4/SiO_2/GO$ core shell nano powders with average particle sizes of 16 nm, 21 nm, and 31 nm, respectively, is confirmed by structural and optical analysis of these powders using methods like XRD. All of the prepared core and core shell samples reported at room temperature exhibit a single semicircle arc in impedance spectroscopy, which denotes the presence of a semiconducting property in the material. These findings show that the Co_3O_4/SiO_2, $Co_3O_4/SiO_2/GO$, and bio-synthesized Co_3O_4 core shell could be useful in a number of applications, including energy storage in pseudo capacitors.

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Table 1. structural parameters

Samples	D nm	d-Spacing	Dislocation density (nm^{-2})	$\varepsilon_{\mu\chi\rho o}$ X 10^{-4}	SF	XRD density (gcm^{-3})
Co_3O_4	16	2.5118	0.0095	0.0376	-0.1980	2.03
Co_3O_4/SiO_2	21	2.4301	0.0597	0.0941	-0.7826	6.07
$Co_3O_4/SiO_2/GO$	31	2.4247	0.1096	0.1275	-0.9114	7.06

NOMENCLATURE

Co	Cobalt
Si	Silica
GO	Graphene Oxide
XRD	X-ray Diffraction
FTIR SF a M Z N$_a$	Fourier transform infrared Stacking fault Volume molecular mass no.of unit cell Avogadro's number
Greek symbols	
λ	X-Ray wavelength
β	full width at half maximum
θ	Diffraction angle
δ ε	Dislocation density microstrain
ϱx	X-ray density
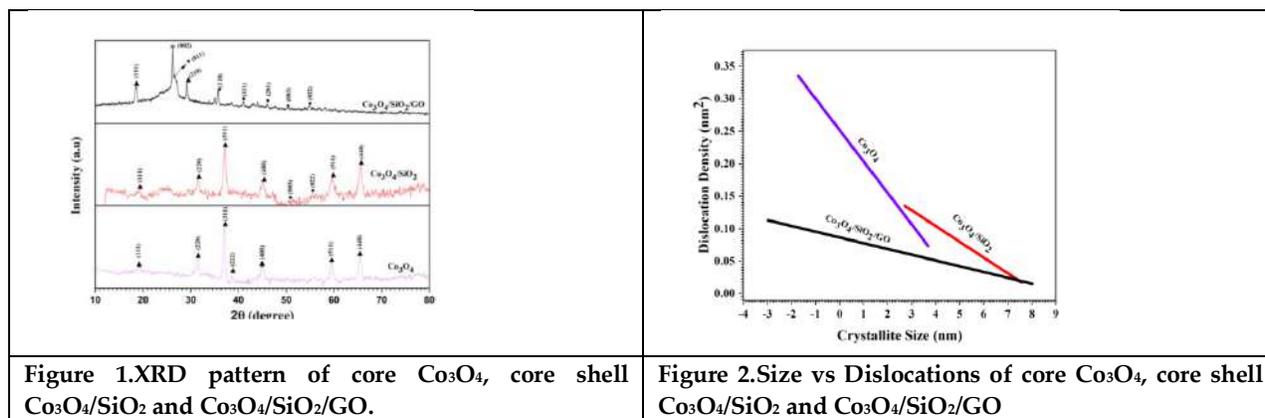
Figure 1.XRD pattern of core Co_3O_4, core shell Co_3O_4/SiO_2 and $Co_3O_4/SiO_2/GO$.	**Figure 2.Size vs Dislocations of core Co_3O_4, core shell Co_3O_4/SiO_2 and $Co_3O_4/SiO_2/GO$**
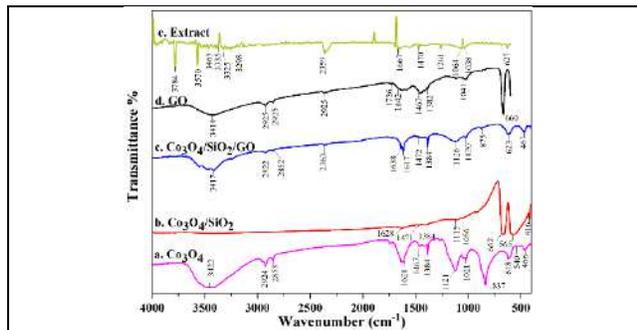
Figure 3 FT-IR spectra of the a) Co₃O₄ core, b) Co₃O₄/SiO₂ core shell, Co₃O₄/SiO₂/GO nanocomposites, d) GO and e) Extract	**Figure 4 Nyquist (Z′ versus Z″) plot for a) Co₃O₄ core, b) Co₃O₄/SiO₂ core shell and c) Co₃O₄/SiO₂/GO nanocomposite**
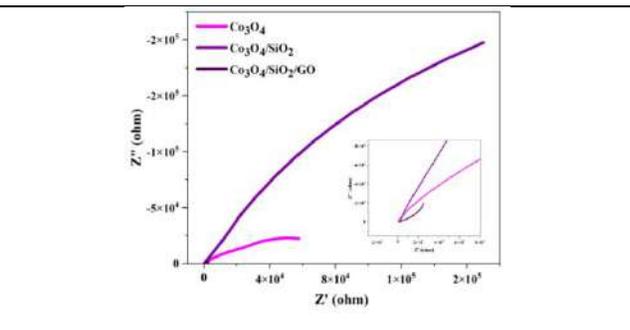
RESEARCH ARTICLE

Evaluation of Antioxidant and Antimicrobial Potential of Marine Seaweeds

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ABSTRACT

Gujarat has 1,600 km of long coastline and is well known for its marine macro algal abundance and diversity. Marine algae also known as seaweed are primitive non-flowering photosynthetic macro phytes occurring in tidal regions of seas and oceans and they are natural renewable resources. The main aim of present study is to anti-oxidant and anti-bacterial properties. The seaweed species were collected from Gopnath, Gulf of Cambay, Gujarat. Based on the results obtained from study it can be proved that the Chlorophyta species of seaweed shows more efficiency for used as antioxidant compared to Rhodophyta species. A seaweed species *Ulva lactuca* demonstrated the highest zone of inhibition in terms of antibacterial and antifungal activity when compared to other seaweed species.

Keywords: Seaweed, Antioxidant, Antibacterial, Anti-fungal, Antimicrobial

INTRODUCTION

The coastal habitat has been referred to as the "Natural Medicine Chest of the New Millennium," and its popularity is rapidly increasing worldwide. Seaweeds are referred as marine macro algae, are a type of heterogeneous plant that thrive in marine or brackish water habitats and grow prolifically on rocky substrates. They are recognized as one of the earliest producers of entire aquatic biomass [1]. According to Ferrara et al. (2020), the classification of algae is primarily based on their pigments, and they are categorized into three main taxonomic groups, namely Phaeophyta, Rhodophyta, and Chlorophyta [2]. The reported number of seaweed species exceeds 10,000, out of which a mere 145 species are utilized for human consumption due to their desirable taste, consistency, or culinary versatility [3]. Additionally, they are known to contain a diverse range of bioactive molecules, including but not limited to protein, amino acids, polyunsaturated fatty acids, vitamins, minerals, dietary fibers, and pigments [4]. The investigation of secondary metabolites, such as alkaloids, phenols, flavonoids, saponins, steroids, tannins, triterpenoids,

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anthraquinones, glycosides, and other active metabolites, has been extensive in the search for therapeutic drugs [5].According to Elsie (2010), the antibacterial properties of phytochemicals make them effective in treating various microbial diseases [6]. Additionally, they function as agents for reducing lipid and glucose levels in the blood, lowering blood pressure, and regulating cholesterol levels. In addition, it has been reported that the aforementioned seaweeds exhibit a significant abundance of essential nutrients such as vitamins A, Bl, B12, C, D, and E, alongside riboflavin, niacin, pantothenic acid, folic acid, and amino acids, as stated by Manam [5]. The increasing popularity of seaweed nutraceutical supplements and functional foods can be attributed to their manifold health benefits. According to a recent study, nations where individuals frequently consume seaweeds had lower rates of obesity and diet-related diseases [7]. The advantageous characteristics of macroscopic algae have long been associated with human and animal existence, and have been utilized as a means of sustenance, animal fodder, soil enricher, and medication. The current investigation focused on the examination and analysis of anti-bacterial and anti-oxidant activities of seaweeds.

MATERIALS AND METHODOLOGY
Study area
The study location chosen is the Gopnath coast, which is approximately 75 kilometers away from Bhavnagar. Geographically, it may be found at coordinates 21.20° N and 72.10° E in the Gulf of Khambhat (Fig. 1). The terrain near the shoreline is marked by a significant abundance of rocky formations. The abundance and variety of seaweeds at Gopnath can be attributed to the favourable substrate conditions.

Seaweed collection and powder preparation
Different seaweed species were collected from the Gopnath region during low tide conditions and promptly transported to the laboratory.

Powder preparation
The preparation of the seaweed powder involved a two-step process of sun drying in which collected seaweeds were allowed to dried for 5-6 days followed by oven drying. Then the dried material was crushed using grinder and stored for future analysis.

Antioxidant assay
For the assessment of antioxidant properties, a methanol solution was used to extract a total of nine species of seaweed. The antioxidant capacity of seaweeds was assessed by quantifying their ability to scavenge free radicals using 2,2-diphenyl-1-picrylhydrazyl (DPPH). The reaction mixture contains 2.5 mL of DPPH solution   and a 0.1 to 0.3 mL of plant extract and then the total volume was made   up to 3mL using methanol. The OD was taken at 0 min and after 30 min   at 517 nm. The standard [8] used for experiment was butylated hydroxytoluene (BHT). The extract's ability to scavenge hydrogen peroxide and its reducing power were assessed using the methodology outlined by Sobuj et al. [9].

Antimicrobial activity
Antibacterial study
The seaweed samples for antibacterial study were prepared in six different solvents (Hexane, Methanol, Chloroform, Dichloromethane, Ethanol and Acetone). The N-agar plates were prepared and two bacterial cultures(*B. subtilis* and *E. coli*) were poured on n-agar plate. Then a well of 6mm size were aseptically punched using a sterile cork borer after that the 100 µl methanolic extracts of seaweed were transferred into separate wells. These plates were incubated at 37°C for 24-48 hours. After that the zone of inhibition of each extract was measured.

Antifungal assay
Antifungal activities of the different crude seaweed extracts were performed using the agar well-diffusion assay. Two fungal Inoculum of (*Aspergillus niger* and *Mucor mucedo*) was prepared by growing the fungal culture in the Potato dextrose agar medium and then the test compound was suspended in tween 80 solution. The fungal suspensions were uniformly spread over Potato Dextrose Agar plate using sterile cotton swab followed

by punching of 6 mm wells using cork borer. The wells were filled with seaweed extract of three species. Fluconazole and methanol were used as a standard and control respectively [10].

RESULTS AND DISCUSSION

Seaweed diversity
During the study period, seaweeds constituted species enlisted as per the classes. A total of nine seaweed species were identified during study period (Fig 3).

Antioxidant Assay
Seaweeds are a valuable source of natural antioxidant chemicals, expanding the range of natural antioxidants beyond terrestrial sources. The identification of phyto constituents, including phenols, flavonoids, and tannins, in seaweed reveals that its extract may possess antioxidant properties. This activity was thought to aid in the prevention of several diseases by scavenging free radicals.[11].

DPPH Assay
The assay is based on the ability of antioxidants to neutralize the stable free radical DPPH (2,2-diphenyl-1-picrylhydrazyl).. Methanol extracts of seaweeds significantly reduced DPPH radicals in dose-dependent manners. The DPPH scavenging activity was found maximum in Chlorophytaspecies i.e., *Ulva lactuca* (65%) species followed by *Enteromorpha compressa* (41%) and *Ulva conglobata* (38%) (Fig 4). *Ulva lactuca* shown significant potential for DPPH radical scavenging activity, comparable to that of commercial Antioxidants (BHT-67%). Similar result was also reported by Sanger et al (2021)[12]. Minimum activity was found in Rhodophyta species that is *Ahnfeltiaplicata*(11%).

H_2O_2 Scavenging assay
The ability of seaweeds extracts to scavenge H_2O_2 increased with elevated concentrations. Though H_2O_2 exhibits minimal reactivity on its own, but it produces highly reactive species, such as OH •, by its interaction with metals (Fe^{2+} or Cu^{2+}) and superoxide anions in the Haber-Weiss reaction. Hence, the reduction of H_2O_2 is crucial for cellular functioning and could be a desirable characteristic of these seaweed species. The highest H_2O_2 scavenging activity was recorded in *Ulva lactuca* (52.6%) followed by *Enteromorpha compress* (35.8%) and *Ulva conglobata* (34.2%) (Fig 5). During the experiment it wasobserved that Chlorophyta members have highest scavenging activity followed by Rhodophyta members.

Reducing Power
The presence of reductones in seaweeds is responsible for their ability to reduce capacity and their involvement in preventing chain initiation, binding metal ions, decomposing peroxides, and scavenging radicals. The methanolic extract of seaweeds exhibited a higher reducing capacity than the well-known antioxidantascorbic acid (ASA). Chlorophyta species *Ulva lactuca*, *Enteromorpha compressa* and Rhodophyta species *Catenellaimpudica* shows the highest concentration that is 3.73, 3.44 and 2.4 µg/mL respectively. Similar results were also obtained by [13]**.**

Antimicrobial Assay
Antibacterial activity
Optimization of solvent for Extraction
The antibacterial effect of seaweed extracts was investigated using various solvents, such as acetone, chloroform, methanol, ethanol, hexane, and DCM, through the agar well diffusion test method against two bacterial species. Table 1 highlight the antibacterial efficacy of various seaweed extracts. Out of the six solvents that were examined, the Acetone extract showed the highest level of inhibition on the growth of the bacterial species that were tested. The acetone extract exhibited the most potent inhibitory action against the selected bacterial strains,

surpassing the inhibitory activity of other solvent extracts. The acetone extract exhibited the highest level of activity against *B. subtilis* (9 mm) and *E. coli* (6 mm) (Fig 6).

Antimicrobial activity of Acetone extract

The microbiological organisms Escherichia coli and Bacillus subtilis exhibited different levels of antibacterial activity when exposed to three different seaweed extracts. Different species of seaweed were collected and analysed for their antibacterial activity. Chlorophyta species of seaweeds was most effective among studied species for their antibacterial activity. The methanol extract of *Ulva lactuca* shown highest activity against *E. coli* (8 mm) followed by *B.subtilis* (7 mm) similarly *C. impudica* shows the highest activity against *E.coli* followed by *B.subtilis* whereas the seaweed species Enteromorpha compress a shows highest *B. subtilis* (5.25mm) followed by *E.coli* (4.5mm). The *U. lactuca* was most active against all tested pathogens. The extracts of almost all studied species shown activity against B. subtilis *E. coli* which is relatively very close to the standard antibiotic Vancomycin and ampicillin 10mcg (Table 2 and Fig 7).

Antifungal activity
Optimization of Concentration for Antifungal activity

The antifungal activity of seaweed extracts was studied by using different concentration viz., 20 ppm, 40 ppm, 60 ppm, 80 ppm and 100 ppm by agar well diffusion test technique against three different fungal species. Table 3 shows the antifungal activity of different concentration of seaweed. Among the five-concentration tested, extract having 100 ppm concentration exhibited maximum inhibition on the growth of the tested fungal species (Fig 7).

Antifungal activity of optimized dose (100ppm)

The methanolic extracts of seaweed species were evaluated for their antifungal activity against two pathogenic fungi, *Aspergillus niger* and *Mucor mucedo.* The results demonstrated the significant antifungal activity of the seaweed extract. The Chlorophyta species *Ulva lactuca* showed maximum antifungal activity against both tested pathogenic organisms *A. niger* (10.25 mm) and *M. mucedo* (8 mm) whereas minimum inhibition was recorded in *Enteromorpha compress* that is 3.5mm and 4.25 mm for *A. niger* and *M. mucedo* respectively (Table 4 and Fig 8). Phenolic compounds are very potent to show the antifungal activity against such pathogens [14]. The antifungal effects of extracts were comparable with the standard antifungal agent, fluconazole as standard antifungal agent and were establish to be active against both the fungal strain tested and showed similar zone of inhibition with seaweed extract. In the present experiment, the Chlorophyta species showed the strongest activities against the test bacteria and fungi, similar result was obtained by Padmakumar and Ayyakkannu[15][16].

CONCLUSION

The Gopnath coast offers a diverse array of seaweed species, which can be attributed to the availability of suitable substratum that provides an appropriate habitat for most algal species. Based on the results obtained from DPPH Assay, reducing power, H_2O_2 scavenging assay it can be proved that the Chlorophyta species of seaweed shows more efficiency for used as antioxidant compared to Rhodophyta species. A seaweed species *Ulva lactuca* demonstrated the highest zone of inhibition in terms of antibacterial and antifungal activity when compared to other seaweed species. So, from this study it can be concluded that the Chlorophyta species specially *Ulva lactuca* has the potential to use as antioxidant agent, it can be also used as natural antifungal and antibacterial agent.

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Table 1 Zone of inhibition (mm) of diff solvents

	Zone of inhibition (mm)	
	B. subtilis	*E.coli*
Hexane	NA	NA
Acetone	9	6
Methanol	6	3
Ethanol	5	2
DCM	NA	NA
Chloroform	NA	NA

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Table 2 Zone of inhibition for different seaweeds

Seaweed Speceis	Zone of inhibition in mm	
	B. Subtilis	*E. Coli*
Catenellaimpudica J. Agardh	1.75	3
Enteromorpha compressa L.	5.25	4.5
Ulva lactuca L	7	8
Vancomycin	6.25	0
Amphicilin	0	1
Control	0	0

Table 3 Zone of inhibition of diff concentration

Concentration (PPM)	Zone of inhibition (cm)		
	Penicillium	*Mucor*	*Aspergillus*
20	0.3	0.2	0.2
40	0.4	0.4	0.3
60	0.6	0.5	0.5
80	0.7	0.7	0.8
100	0.9	0.8	1

Table 4 Zone of inhibition of different seaweeds

Anti-Fungal Activity			
	Mucor	*Penicilium*	*A. Niger*
Catenellaimpudica J. Agardh	4.5	2.5	4.25
Enteromorpha compressa L.	4.25	4.25	3.5
Ulva lactuca L	8.75	2.75	10.25
Fluconazole	9.25	1.25	8.5
Control	0	0	0
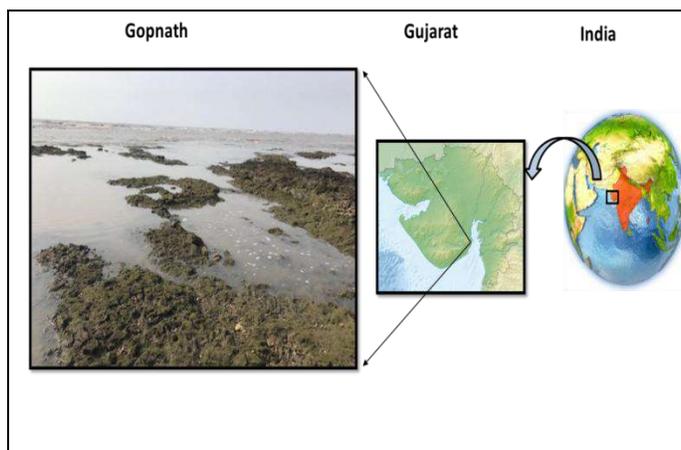
Figure 9 Map showing study area Gopnath-Khambhat, Gujarat	**Figure 10 Antimicrobial activity of Seaweed**
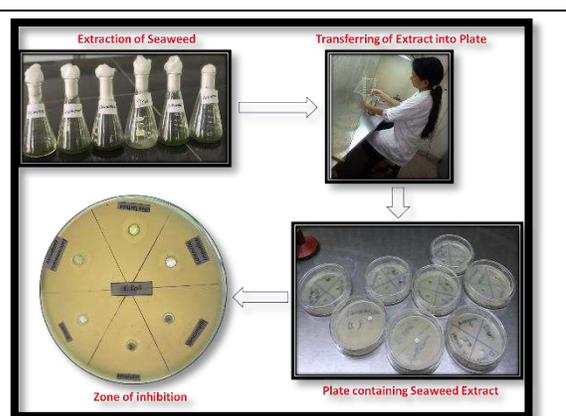
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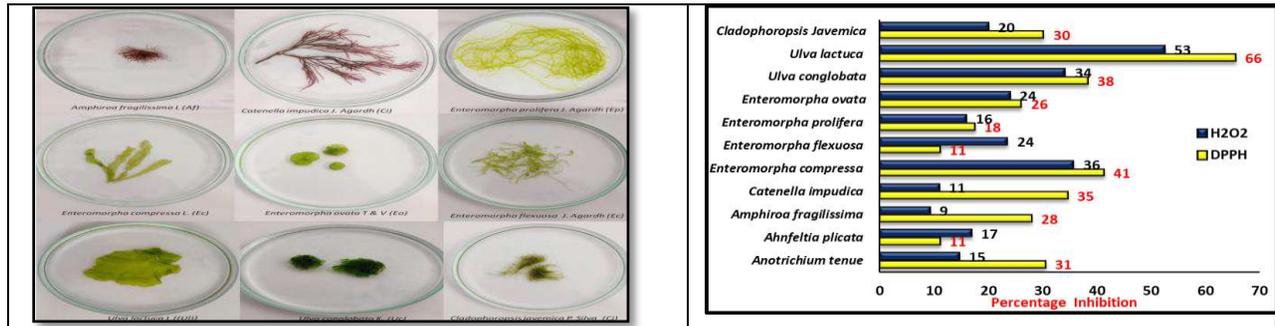
Figure 11. Collected Seaweed species

Figure 12. DPPH Assay and H2O2 assay of different seaweeds
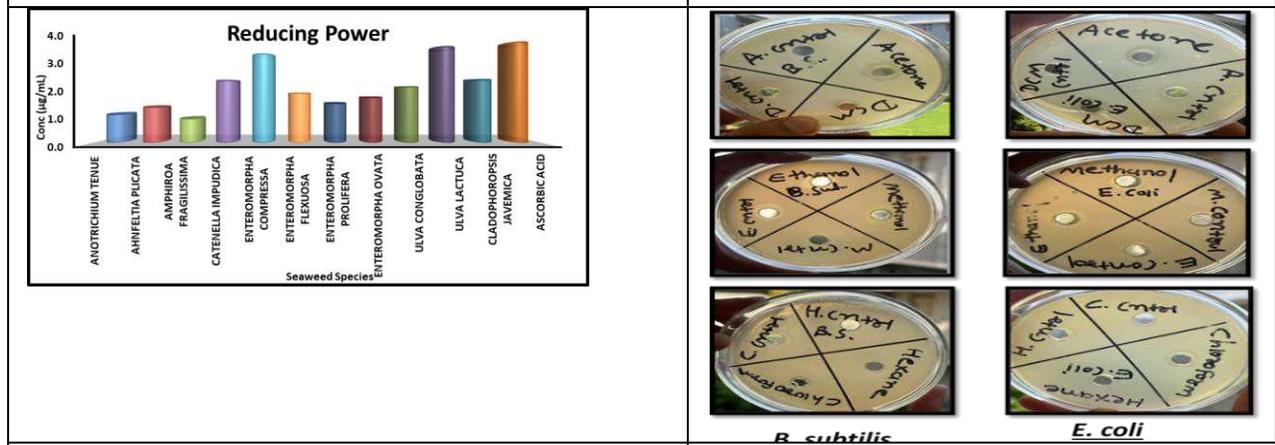
Figure 13 Reducing power of different seaweeds

Figure 14 Optimization of different solvents for *B.subtilis* and *E. coli*
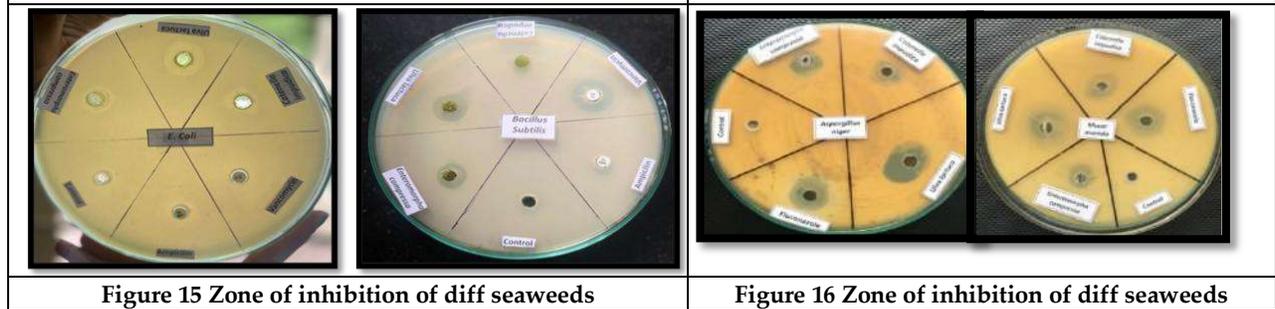
Figure 15 Zone of inhibition of diff seaweeds

Figure 16 Zone of inhibition of diff seaweeds

RESEARCH ARTICLE

Leveraging Inverse Reinforcement Learning for Cyber security in Smart Cities Learning from Patterns, Safeguarding Cities: Inverse Reinforcement Learning Strategies for Resilient Cyber Defenses in Smart Urban Infrastructures

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ABSTRACT

This study investigates the role of Inverse Reinforcement Learning (IRL) in fortifying cyber security within smart cities, recognizing the escalating integration of advanced technologies in urban landscapes. Addressing cyber security challenges, including IoT vulnerabilities and privacy concerns, the paper explores IRL's potential in analyzing user behaviors and system interactions to detect cyber threats. It discusses the development of adaptive cyber security systems driven by IRL, emphasizing real-time threat mitigation. Ethical considerations and future prospects, envisioning AI-driven threat analysis and secure-by-design strategies, are also examined. The paper aims to contribute insights into leveraging IRL for safeguarding smart city infrastructures, fostering resilient urban environments.

Keywords: Inverse Reinforcement Learning (IRL), Smart city cyber security, Urban infrastructure security, Internet of Things (IoT) security, Anomaly detection, Behavioral modeling, AI-driven threat analysis, Secure-by-design approaches, Ethical considerations, Privacy-preserving techniques, Human-centric cyber security, Adaptive cyber security strategies, Future trends in IRL, Threat prediction in smart cities, Context-aware cyber security.

INTRODUCTION

In recent years, the rapid evolution of technology has catalyzed the transformation of conventional urban spaces into interconnected smart cities, fostering efficiency, connectivity, and innovation. However, this integration of technology into urban infrastructure has concurrently amplified vulnerabilities, posing significant cyber security challenges. Ensuring the resilience of smart city systems against cyber threats and attacks has become a critical concern. In response to these challenges, this paper investigates the application of Inverse Reinforcement Learning (IRL) as a strategic framework for enhancing cyber security measures within the context of smart cities. With the burgeoning complexity and interconnectivity of urban infrastructures, the study aims to explore how IRL can decipher and predict cyber threats, detect anomalies, and ultimately contribute to the development of adaptive cyber security systems tailored to the dynamic nature of smart city environments. Through an ethical lens and forward-looking perspective, this research endeavors to offer insights into leveraging IRL as a potential solution for fortifying the digital resilience of smart urban landscapes.

Prior Research Insights: IRL Applications in Smart City Cyber security

Research within the domain of Inverse Reinforcement Learning (IRL) has increasingly recognized its potential applications in addressing cyber security challenges specific to smart cities. Existing studies offer insights into the utilization of IRL techniques for enhancing the security posture of urban environments. For instance, Maxim Kalinin et al., 2021 [1] conducted a comprehensive analysis on Cyber security Risk Assessment in Smart City Infrastructures which presented a novel approach to cyber security risk management in smart cities using object typing, data mining, and quantitative risk assessment, employing artificial neural networks for automated and accurate risk evaluation across diverse object types within the dynamic digital infrastructure. Similarly, H. Habibzadeh et al., 2019[2]in their paper outlined the dual facets of challenges and opportunities in deploying Cyber Physical Systems (CPSs) within smart cities, encompassing technical, policy, and governance considerations crucial for implementation success. These studies collectively underscore the feasibility and efficacy of IRL in deciphering nuanced cyber threats prevalent in the complex ecosystems of smart cities. Moreover, the review article of I.V.D. Srihith et al [3] explores the multifaceted role of AI, machine learning, and advanced technologies like Deep Reinforcement Learning (DRL) and Machine Learning (ML) in addressing diverse aspects of smart cities while outlining research challenges and future directions for smart city advancement.

In addition to threat detection, IRL has been investigated for its potential in inferring user behaviors and decision-making, contributing to proactive security measures. The published paper of David Massimo [4] introduced the application of Recommender Systems in Internet of Things (IoT) contexts, outlining a novel learning approach for generating explainable human behavior models and recommendations in sensor-enabled environments, along with techniques for simulating user behavior and analyzing collective dynamics. These findings underscore the significance of leveraging IRL to analyze and predict human behaviors in enhancing preemptive cyber security strategies tailored for urban settings. In recent times, the integration of the Internet of Things (IoT) into smart cities has significantly enhanced operational efficiency and the quality of life. However, this proliferation of IoT devices has concurrently escalated cyber security risks, exposing vulnerabilities to malicious attacks. To combat these threats, various studies [5, 6, 7, 8] have delved into employing machine learning (ML) techniques for attack and anomaly detection within IoT networks of smart cities. These investigations explore diverse ML algorithms, including LR, SVM, DT, RF, ANN, KNN, ensembles (bagging, boosting, stacking), and cross-validation to bolster cyber security defenses. Emphasizing the significance of ML in cyber threat identification, these studies highlight its potential in addressing numerous security challenges such as intrusion detection, malware identification, and anomaly detection in IoT devices. Furthermore, they underscore the evolving nature of IoT security threats and the pivotal role of ML in countering these challenges, affirming ML as a promising technology for enhancing IoT security measures. The acquisition of human travel behavior data at various granularity levels is vital for urban planning and transportation management. However, conventional travel surveys often lack frequency and fail to adapt to evolving transportation

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dynamics. Addressing this challenge, [9, 10] propose innovative approaches using Inverse Reinforcement Learning (IRL) and synthetic data generation techniques. In [9], an IRL-based framework is introduced to model individual decision-making in urban settings, utilizing real-time GPS data to replicate human travel behavior patterns. The results showcase the model's capability to simulate individual travel plans and estimate city-wide travel demand, offering insights into hourly population distribution without compromising individual privacy. Complementing this, [10] highlights the significance of synthetic data in preserving sensitive information while resembling original datasets. This systematic review assesses diverse synthetic data models for urban mobility, emphasizing their practical applicability and potential for safeguarding privacy in mobility datasets. Exploring the realm of smart city applications involving Unmanned Aerial Vehicles (UAVs), this research project [11] focuses on area scanning using advanced UAVs with enhanced sensory capabilities. The evolution of these devices, marked by increased range and capacity, has facilitated automation, minimizing the reliance on human resources. Applications encompass traffic and pollution monitoring, land surveying, civil security control, and natural disaster monitoring.

To optimize UAV operations, the study examines the potential integration of Monte-Carlo Tree Search (MCTS) and Reinforcement Learning (RL), established methods in control tasks, aiming to develop efficient algorithms suited for diverse UAV applications within smart cities. Addressing the escalating issue of traffic congestion in urban areas, multiple research studies [12, 13, 14, 15, 16, 17] propose innovative strategies employing Reinforcement Learning (RL) and Vehicular Ad-hoc Networks (VANETs) to optimize traffic flow and alleviate congestion. These studies explore diverse approaches, including multi-agent RL frameworks, Q-learning, Markov Decision Processes (MDPs), and predictive road traffic management systems. Source [12] introduces a futuristic concept allowing structural modifications to the urban layout for enhanced traffic management, achieving a notable 31.5% reduction in total travel time (TTT). Meanwhile, [13], [14], [15] delve into RL-based approaches, considering path selections, speed regulation, and congestion avoidance through diverse algorithms and reward functions, demonstrating promising performance in congestion reduction and traffic optimization.

Additionally, [16] proposes a predictive traffic management system leveraging VANET architecture, showcasing significant enhancements in total journey time and vehicle waiting time. Furthermore, [17] explores group-based routing methods considering vehicles' similarities in urban transportation environments, aiming to enhance urban development and optimize traffic distribution. These studies collectively underscore the potential of RL-driven solutions and VANETs in devising effective strategies to mitigate traffic congestion and improve urban traffic management. Collectively, these studies offer valuable insights into the multifaceted applications of IRL within the realm of smart city cyber security, showcasing its potential in anomaly detection, adaptive security, and understanding user behaviors to bolster the resilience of urban infrastructures against cyber threats. These insights underscore the versatility of IRL, positioning it as a strategic tool to fortify the digital defenses of complex urban environments. In the context of prior research insights on IRL applications within smart city cyber security, Table I outlines ongoing research directions specifically tailored for the advancement of Inverse Reinforcement Learning (IRL) in urban environments. This table highlights crucial areas of exploration in IRL, emphasizing the need for continued research and ethical considerations in fortifying cyber security measures.

Challenges in Smart City Cyber security
As smart cities continue to evolve with technological integration, they encounter a spectrum of cyber security challenges unique to their complex and interconnected infrastructures.

Vulnerabilities in IoT Devices and Infrastructures
The proliferation of Internet of Things (IoT) devices within smart cities introduces vulnerabilities that pose significant security risks. These devices, often interconnected and resource-constrained, become potential entry points for cyber-attacks. Vulnerabilities include insufficient security protocols, lack of firmware updates, and susceptibility to exploitation, thereby compromising the integrity of critical systems such as traffic management, public services, and energy distribution.

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Complexity of Interconnected Systems

Smart cities consist of diverse systems and networks interconnected to enable efficient functioning. However, this intricate web of interconnected systems amplifies the attack surface, rendering it susceptible to sophisticated cyber threats. The complexity arises from the integration of multiple components, each with its own security protocols and compatibility requirements, thereby heightening the challenge of maintaining comprehensive cybersecurity measures across the entire ecosystem.

Data Privacy Concerns

The collection and utilization of vast amounts of data within smart cities for improving services and decision-making processes raise profound privacy concerns. The seamless integration of data from various sources, including IoT sensors, surveillance systems, and citizen interactions, necessitates stringent measures to safeguard personal information. Ensuring data privacy while harnessing the benefits of data-driven innovations remains a critical challenge.

Evolving Cyber Threat Landscape

The dynamic nature of cyber threats poses an ongoing challenge for smart city cyber security. Attack methodologies continually evolve, encompassing a wide array of threats, including malware, ransom ware, phishing attacks, and zero-day vulnerabilities. The rapid evolution of attack techniques necessitates proactive measures to anticipate and mitigate emerging threats promptly.

Human Factor and Awareness

Human error and lack of cyber security awareness among smart city inhabitants and stakeholders contribute significantly to cyber security vulnerabilities. Inadequate cyber security education and training, coupled with complacency, increase the susceptibility to social engineering attacks, compromising the overall security posture of smart city systems.

Fundamentals of Inverse Reinforcement Learning

Inverse Reinforcement Learning (IRL) serves as a fundamental framework that enables machines to infer human-like behaviors and decision-making processes by observing and learning from expert demonstrations. This section aims to elucidate the foundational principles and key components of IRL in the context of cybersecurity within smart cities:

Understanding the Concept of IRL

At its core, Inverse Reinforcement Learning involves inferring an underlying reward or objective function from observed behaviors rather than directly learning a policy. Unlike traditional Reinforcement Learning (RL), where the agent learns from reward signals, IRL focuses on deducing the hidden rewards guiding expert behavior.

Key Components of IRL

1. **Reward Inference:** IRL operates under the assumption that observed expert behaviors are optimal concerning an unknown reward function or objective. Instead of directly learning a policy as in RL, IRL aims to reverse-engineer this reward function. It endeavors to uncover the latent reward signals that likely drive the observed behaviors, allowing machines to discern the implicit decision-making criteria.
2. **Modeling Behavioral Preferences:** The core challenge in IRL involves interpreting observed trajectories or sequences of actions taken by experts. By analyzing these behavioral demonstrations, IRL seeks to discern patterns and preferences inherent in the expert's actions. This modeling process involves understanding how the observed behaviors align with the inferred reward function, enabling the learning agent to generalize and make decisions in line with the expert's behavior.
3. Optimization for Reward Inference: IRL encompasses a spectrum of optimization methods employed to infer the most probable reward function governing expert behavior. Techniques include maximum likelihood estimation and various IRL algorithms, each aimed at reducing the latent rewards that best explain the observed actions. These algorithms iteratively refine the inferred reward function to align more closely with observed behaviors.

Suitability of IRL in Cyber security for Smart Cities

IRL's ability to model complex decision-making processes and infer underlying objectives aligns with the dynamic and intricate nature of cyber security within smart cities. By analyzing behavioral patterns and inferring rewards, IRL presents a promising avenue for understanding and predicting cyber threats, detecting anomalies, and formulating adaptive security strategies tailored to urban environments.

Applications of IRL in Smart City Cyber security

The utilization of Inverse Reinforcement Learning (IRL) techniques within the cyber security landscape of smart cities presents a transformative approach to address cyber threats. IRL methods exhibit promising applications in various domains, facilitating the analysis of user behaviors, network traffic, and system interactions to detect anomalies and preempt potential cyber threats. This section delineates the specific applications of IRL techniques and their role in fortifying adaptive cyber security strategies within urban environments:

Analyzing User Behaviors

IRL enables the modeling and analysis of user behaviors across diverse smart city applications and services. By observing interactions between users and urban systems, IRL discerns behavioral patterns and deviations, aiding in the identification of anomalies that may signify potential cyber threats. Understanding user behaviors assists in formulating adaptive security measures tailored to mitigate emerging risks.

Network Traffic Analysis

The intricately interconnected network infrastructure within smart cities necessitates vigilant monitoring of network traffic. IRL techniques excel in analyzing network data, identifying abnormal traffic patterns, and detecting potential cyber intrusions or attacks. Leveraging IRL for network traffic analysis empowers security systems to adapt dynamically, responding promptly to emerging threats and vulnerabilities.

System Interactions and Anomaly Detection

By observing system interactions and operational data, IRL facilitates the detection of anomalies indicative of cyber security breaches or irregular system behavior. Through trajectory analysis and reward inference, IRL identifies deviations from expected system behaviors, enhancing the capability to preemptively detect and mitigate potential cyber threats within smart city infrastructures.

Empowering Adaptive Cyber security Strategies

IRL's capacity to learn from observed behaviors and adapt in real-time plays a pivotal role in empowering adaptive cyber security strategies within smart cities. The ability to infer underlying reward structures and model optimal decision-making aids in crafting agile and responsive security measures capable of dynamically adapting to evolving cyber threats, ensuring the resilience of urban systems.

Ethical Implications and Privacy Concerns

The deployment of Inverse Reinforcement Learning (IRL) techniques in cyber security within smart cities presents ethical considerations and privacy concerns that warrant careful deliberation. As IRL-driven security systems collect, analyze, and act upon data from urban environments, ethical considerations arise, primarily focusing on privacy preservation and broader ethical implications. One of the paramount ethical concerns revolves around the preservation of individual privacy amidst the utilization of IRL for cyber security purposes. The pervasive data collection required for behavioral analysis and anomaly detection within smart city environments raises concerns about potential intrusions into citizens' privacy. Striking a delicate balance between enhancing cyber security measures and safeguarding individual privacy rights necessitates stringent data anonymization, encryption, and robust privacy-preserving mechanisms. The opacity surrounding the operation of IRL algorithms and their decision-making processes accentuates the ethical imperative for transparency and accountability.

As IRL systems learn from observed behaviors to predict cyber threats, ensuring transparency in algorithmic decision-making becomes crucial. Establishing mechanisms for explaining IRL-derived decisions and fostering algorithmic accountability frameworks becomes imperative to engender trust and comprehension among stakeholders. The potential for biases inherent in IRL algorithms poses ethical challenges, particularly concerning fairness and impartiality. Biases embedded in training data or algorithmic models might perpetuate disparities or discrimination, impacting decision outcomes. Therefore, rectifying biases and ensuring fairness in IRL-based cyber security systems demands rigorous bias mitigation strategies, ethical algorithm design, and continuous evaluation to prevent discriminatory outcomes. Respecting individuals' rights to informed consent and fostering citizen awareness regarding the use of IRL-based cyber security measures in smart cities becomes pivotal. Providing clear and comprehensive information about data collection practices, behavioral analysis, and the purpose of cyber security initiatives enables citizens to make informed decisions about their participation and encourages active engagement in enhancing cyber security while safeguarding privacy.

Future Perspectives

The future landscape of Inverse Reinforcement Learning (IRL) applications within smart city cyber security holds promising prospects, poised to witness remarkable advancements and innovative trajectories. This Fig. 1, illustrates anticipated advancements in Inverse Reinforcement Learning (IRL) applications within the realm of cyber security for smart cities. It visually showcases several key trends

AI-Driven Threat Analysis

Anticipated advancements in IRL envision the integration of advanced artificial intelligence techniques to drive more sophisticated threat analysis and prediction models within smart cities. These AI-powered systems would harness IRL's capacity to discern behavioral patterns, enabling the proactive identification and prediction of cyber threats. For instance, future IRL-based systems might utilize deep learning architectures to detect subtle anomalies in user behaviors or network traffic, forecasting potential threats before they manifest.

Contextual Adaptability and Dynamic Response

Future IRL applications in smart city cyber security are poised to emphasize contextual adaptability and real-time response capabilities. These systems would exhibit heightened adaptability to dynamic urban environments by continuously learning from evolving cyber threats and adjusting security measures accordingly. For instance, IRL-based cyber security systems might dynamically reconfigure network defenses or access control protocols in response to detected anomalies, ensuring rapid and contextually relevant countermeasures.

Secure-by-Design Approaches and Ethical AI Integration

The future direction of IRL applications emphasizes the integration of secure-by-design principles into cyber security frameworks within smart cities. Future IRL systems will prioritize ethical considerations and privacy preservation from their inception, embedding ethical AI guidelines into algorithmic development. For instance, the design of IRL algorithms might integrate privacy-preserving techniques such as federated learning or differential privacy to ensure robust security measures without compromising individual privacy rights.

Human-Centric Cyber security and Behavioral Modeling

As IRL advances, future applications in smart city cyber security will increasingly focus on human-centric approaches by delving deeper into behavioral modeling and understanding. These systems will employ more nuanced and granular behavioral analysis to predict and thwart cyber threats. For example, future IRL models might incorporate cognitive psychology principles to model human decision-making, enhancing the accuracy of anomaly detection based on human behavior analysis.

CONCLUSION

In closing, the exploration of Inverse Reinforcement Learning (IRL) within the context of smart city cyber security illuminates its profound potential. From the extensive literature review and discussions, it becomes evident that IRL holds the key to transformative advancements in fortifying urban infrastructures against evolving cyber threats. Its ability to decipher behavioral patterns, predict anomalies, and enable adaptive security strategies underscores its significance in enhancing cyber security measures tailored for smart cities. However, as we navigate this promising trajectory, ongoing research remains imperative. Continuous innovation and exploration into IRL methodologies are crucial to harness its full potential. Moreover, ethical considerations stand as paramount pillars in implementing IRL-based solutions, demanding vigilance in safeguarding individual privacy rights, ensuring transparency, and mitigating biases. Embracing these dual imperatives—ongoing research and ethical adherence—will pave the way for the responsible and effective deployment of IRL, fostering resilient and secure smart city ecosystems for the benefit of society.

ACKNOWLEDGMENT

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Table 1 Key Research Directions in IRL for Smart Cities

Research Direction	Description
Advancing IRL algorithms for anomaly detection	Development of more robust IRL algorithms specialized in detecting subtle cyber threats.
Privacy-preserving IRL techniques	Exploration of methodologies ensuring robust privacy while leveraging IRL for cybersecurity.
Human-centric IRL models for behavioral analysis	Emphasis on modeling human behaviors for accurate anomaly detection and threat prediction.
Context-aware IRL applications	Research into IRL systems capable of dynamically adapting to diverse smart city environments.

Fig. 1 .Future Trends in Inverse Reinforcement Learning for Cyber security in Smart Cities

RESEARCH ARTICLE

Effectiveness of Muscle Energy Technique vs. McKenzie Exercise Combined with Janda's Approach for Upper Crossed Syndrome Management in Lactating Women: A Comparative Study

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ABSTRACT

The primary objective of this study is to evaluate and contrast the efficacy of Muscle Energy Technique and McKenzie exercise, when employed in conjunction with Janda's approach, for the management of Upper Crossed Syndrome in lactating women. A comparative study was conducted at the Faculty of Physiotherapy, Dr. MGR Educational and Research Institute. Thirty lactating women diagnosed with UCS, aged 25-40 years, were recruited. They were randomly allocated to either Group A (MET with Janda's approach) or Group B (McKenzie exercise with Janda's approach). The interventions were carried out for five weeks. Outcome measures included the Cranio vertebral angle (CVA) as an indicator of posture and the Neck Disability Index (NDI) to assess functional impairment. Statistical analysis was performed using appropriate tests. After the intervention period of 5 weeks, a significant improvement in the Cranio vertebral angle was observed for both the Muscle Energy Technique and McKenzie exercise interventions. However, Group B (McKenzie exercise) exhibited a higher mean Cranio vertebral angle of 46.13, indicating greater effectiveness compared to Group A (Muscle Energy Technique) with a mean angle of 44.32. This difference was statistically significant at $P \leq 0.001$. n terms of the Neck Disability Index, both groups demonstrated a noteworthy reduction in post-test mean values following the

intervention. Group B (McKenzie exercise) displayed a lower mean value of 12.12, reflecting more effective outcomes in comparison to Group A (Muscle Energy Technique) with a mean value of 15.31. This difference was also statistically significant at P ≤ 0.001.

Keywords: Muscle energy technique, McKenzie exercises, Janda's approach, Upper Crossed Syndrome, Lactating women

INTRODUCTION

Upper Crossed Syndrome (UCS) develops when the muscles in the neck, shoulders, and chest become imbalanced, typically due to poor posture. This results in tightness of muscles like the levator scapulae, upper trapezius, and pectoralis minor, along with occasional tightness of the pectoralis major, coupled with weakness in deep neck flexors, lower trapezius, and rhomboids[1,2]. This pattern creates an X-shaped muscle imbalance[3]. This muscular imbalance leads to joint dysfunction, particularly affecting joints such as the atlanto-occipital joint, C4-C5 segment, cervicothoracic joint, glenohumeral joint, and T4-T5 segment[4,5]. The postural changes associated with UCS encompass forward head posture, increased cervical lordosis, thoracic kyphosis, elevated and protracted shoulders, and rotation or abduction with winging of the scapulae[5]. These changes compromise glenohumeral stability, as the glenoid fossa becomes more upright due to the weakening of the serratus anterior, resulting in shoulder abduction, rotation, and winging[6]. This weakened state necessitates increased activation of the levator scapulae and upper trapezius muscles to maintain proper glenohumeral alignment. Such a situation ultimately leads to side effects like pain and inflammation in the affected muscles[7]. Cervical pain is a commonly encountered musculoskeletal issue, which if untreated, can lead to severe complications[8]. Its occurrence is influenced by various factors, including musculoskeletal structure, age-related body changes, cultural practices, motor performance, and occupation.

This condition tends to be more prevalent among women, in higher-income countries compared to lower- and middle-income countries, and in urban areas[9]. Breastfeeding offers numerous physical and mental health benefits for both mothers and infants. The posture adopted during breastfeeding, intended to facilitate comfortable latching and milk flow, can sometimes contribute to issues like mechanical neck pain, brachial plexus discomfort, carpal tunnel syndrome, and various spinal deviations[10]. Upper Crossed Syndrome can also arise due to poor positioning of infants during breastfeeding, along with the adaptive postures mothers adopt while nursing[11]. These musculoskeletal problems associated with posture are influenced by different breastfeeding positions, which can either exacerbate or alleviate them. The resulting pain can manifest anywhere in the body and may occur during or after breastfeeding[12]. Physiotherapy interventions involve specialized exercises aimed at elongating muscles, enhancing strength and stability, and providing pain relief, particularly in the cervical spine. Manual techniques like Mobilization and Manipulation are employed to restore normal joint range of motion, addressing joint hypokinesia.

Muscle Energy Technique (MET), Active Isolate Stretching (AIS), and Strain Counter Strain are soft tissue methods used to treat neck pain and enhance range of motion. This study aims to compare the efficacy of muscle energy technique and McKenzie exercise, combined with Janda's approach. Muscle Energy Technique is an advanced stretching method rooted in Autogenic Inhibition and Reciprocal Inhibition concepts[13]. It aids in strengthening weak muscles by utilizing the length-tension relationship of contracted, spastic, or shortened muscles, ultimately restoring normal joint range of motion[14]. The technique can be executed through post-isometric relaxation and post-facilitation stretch approaches, targeting muscle imbalances and shortened muscles, respectively. MET has also been associated with pain relief[15]. The McKenzie exercise involves repetitive self-therapeutic exercises focused on extension[16]. This strategy encompasses mobilization, manipulation, self-therapeutic exercises, and patient education. It aims to alleviate musculoskeletal issues by improving posture and function, reducing pain recurrence, and alleviating associated stress[17-19].Janda's approach is a traditional technique involving targeted stretching for tight muscles and strengthening exercises for weak muscles. The objective is to enhance posture, diminish pain, and

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reduce inflammation[20]. This study is the pioneering endeavour to assess the effectiveness of muscle energy technique versus McKenzie exercise in lactating women diagnosed with upper crossed syndrome.

MATERIALS AND METHODS

This study employs an experimental design, specifically utilizing the Comparative Pre and Post-test approach. The research was conducted over a span of 5 weeks at the Faculty of Physiotherapy, Dr. M.G.R Educational and Research Institute. The participants included a cohort of a hundred lactating women, all aged around 25 years. The selection criteria were centered on identifying individuals displaying symptoms of upper crossed syndrome. From this initial pool, 30 lactating women who exhibited specific symptoms such as musculoskeletal discomfort in the neck and shoulders, cervicogenic headaches, and forward head posture, were chosen to participate in the study. Exclusion criteria were applied, excluding individuals with a history of cervical spine trauma, instability, other arthritic conditions, or spinal deformities. The chosen 30 subjects were then randomly divided into two groups: Group A and Group B, with each group comprising 15 participants. Clear explanations regarding the study's objectives and the prescribed exercise protocols were provided to all participants. Additionally, each participant completed an informed consent form before any study-related procedures were initiated. Ethical approval for the study was obtained from the University Research and Ethics committee, and the study was meticulously conducted in accordance with the guidelines set forth in the Helsinki Declaration of 2013, as endorsed by the World Medical Association [21]. Baseline measurements, termed pre-test measures, were taken at the outset of the study. These measurements encompassed the assessment of the Neck Disability Index and the cranio vertebral angle. These initial measurements served as a foundation against which subsequent changes were evaluated throughout the study.

Participants allocated to Group A underwent a therapeutic regimen involving Muscle Energy Technique (MET) targeting the upper trapezius, levator scapulae, and pectoralis muscles. The application of MET comprised both post isometric relaxation (PIR) and Post Facilitation Stretch (PFS) techniques. Each session consisted of a single set encompassing 5 repetitions, with a frequency of 3 sessions per week on alternate days. This intervention was carried out in conjunction with Janda's approach and spanned a period of 5 weeks. During the MET stretching exercises, the duration of the stretches was maintained at 8-10 seconds for PIR and 15 seconds for PFS. The participants were positioned in both supine lying and sitting postures during the MET sessions [22]. During the post isometric relaxation (PIR) technique, participants were guided to engage their agonist muscles by exerting approximately 10-20% of their available force, sustaining the contraction for a duration of 5 to 10 seconds. To ensure balanced opposing forces, resistance was applied by the therapist to counter the individual's exertion. Following this contraction phase, participants were directed to achieve complete relaxation.

Subsequently, the therapist would proceed to address the next barrier, eliminating any initial slack in the muscles. This sequential process was repeated for the new barrier, completing a total of 3 to 5 repetitions during each session. The PIR technique was administered thrice weekly as part of the intervention protocol [23]. In the context of post facilitation stretch, the muscles that had become shortened were positioned at a midpoint between their fully stretched and fully relaxed states. During this phase, participants engaged in an isometric contraction of the muscles, exerting a maximum level of effort for a duration of 5-10 seconds. The therapist provided complete resistance against this effort. Upon releasing the contraction, an immediate controlled stretch was applied to reach a new point of resistance. This stretch was executed without any sudden jerking or bouncing motions and was sustained for a minimum of 10 seconds. Following this, participants relaxed for approximately 20 seconds [24]. This sequence of actions was then repeated for the same muscle group, and the entire process was carried out for a total of 3 to 5 repetitions within each session. The post facilitation stretch technique was incorporated into the intervention protocol, with sessions scheduled three times a week.

Trapezius Stretching

During this stretching exercise, the subject assumed a seated position. They were instructed to flex their neck and then rotate it towards the same side as the flexed neck. The head was maintained in a neutral position while the individual lifted the shoulder on the same side as the rotation. To create resistance, a counterforce was gently applied for a duration of 10 seconds, holding the position. Subsequently, the contraction was released, and the muscle was stretched gradually until a new point of resistance was encountered. This entire procedure, involving contraction and subsequent stretch, was repeated for a total of 3 to 5 iterations [25].

Levator scapulae Stretching

The participant, situated in a seated position, is directed to flex their neck and subsequently rotate it towards the opposite side. While maintaining a neutral head position, the individual is then prompted to elevate the shoulder on the same side as the initial neck rotation. To impart resistance, a counter force is gently applied, and this resistance is sustained for a duration of 10 seconds while holding the designated posture. Following the contraction phase, the resistance is released, and a controlled stretch is administered to the muscle until a novel point of resistance is met. This is done for a total of 3 to 5 repetitions during each session [26].

Pectoralis muscle (Clavicular division) Stretching

The participant assumes a supine position, and their arm is extended and abducted until a sensation of tightness is experienced. The extended arm is then maintained in this position and supported by the therapist's leg. The participant is instructed to lift the extended arm, while the therapist simultaneously applies resistance. This resistance is maintained for a duration of 10 seconds. Following the contraction phase, the participant is prompted to release the effort, and the arm is gently slid along its path. This series of actions, encompassing contraction, resistance, and subsequent movement, is repeated for a total of 3 to 5 cycles during each session [27].

Pectoralis muscle (Sternal division) Stretching

The participant lies in a supine position, and their arm is extended and abducted to approximately 45 degrees until they feel a sense of tightness. The extended arm is then upheld in this position, with the therapist's leg providing support. The participant is then directed to lift the arm while the therapist applies resistance. This resistance is sustained for a duration of 10 seconds. After the contraction phase, the participant is instructed to release the exertion, and the arm is gently moved along its trajectory. This sequence of actions, encompassing contraction, resistance, and subsequent movement, is reiterated for a total of 3 to 5 cycles during each session [28].

Mckenzie Exercises

Participants allocated to Group B received treatment involving McKenzie's exercise regimen, performed for 20 minutes per day, three times a week over the course of five weeks. This exercise program was administered in conjunction with Janda's approach [29].

Chin Tucks

The participant is instructed to maintain an upright seated posture and gently lower the chin without tilting the head. This position should be held for a duration of 10 seconds before being released.

NeckRetraction and Extension

The participant is directed to sit in an upright posture and gently retract the neck by pulling it backward. This position should be held for 1-2 seconds before returning to the retracted position. Subsequently, the neck is gradually brought back to the neutral position.

Side Bending Exercise

While maintaining a straight gaze, the participant tilts their head sideways until the ear touches the shoulder. This position should be held for a few seconds before repeating the same movement on the opposite side.

Neck Rotation

Turn the head to the right while keeping the gaze fixed, holding the position for a few seconds. Repeat the same movement on the left side.

Neck Flexion

The participant is guided to lower their head towards the chest. Next, they are to lift their hand and interlock their fingers at the back of the head, using this grip to gently push the head further towards the chin.

Shoulder Shrugs

The participant is instructed to inhale slowly while simultaneously lifting their shoulders towards the ears. The breath is held in this elevated position for a duration of 10 seconds. Subsequently, they are to exhale slowly and gradually return to the initial starting position.

Janda's approach

Janda's approach follows a traditional methodology that involves providing stretches to tight muscles and exercises to strengthen weakened muscles. The primary aim of this approach is to enhance posture, alleviate pain, and reduce inflammation. Additionally, a hydro-collator pack will be applied to the region experiencing cervical pain prior to commencing the treatment [30].

Stretching exercises

Stretching exercises are prescribed for the levator scapulae, upper trapezius, and pectoralis muscles, with each stretch held for a duration of 20 seconds. This sequence is repeated five times per day.

Strengthening exercises

Strengthening exercises are recommended for the middle and lower trapezius, serratus anterior, infraspinatus, and deep neck flexors. Each exercise consists of 2 sets, with 10 repetitions per set, to be performed daily.

RESULTS

The gathered data were organized and examined through a combination of descriptive and inferential statistical methods. The statistical package for social science (SPSS) version 24 was employed to analyze all the parameters. For within-group comparisons, the paired t-test was utilized to ascertain any statistical distinctions. To determine the statistical differences between the groups, the independent t-test (also known as the Student t-Test) was employed.

The provided table displays the Mean, Standard Deviation (S.D), t-test results, degree of freedom (df), and p-values for the comparison of pre-test and post-test week data between Group A and Group B. The data in the table indicates that there is no notable difference in pre-test values between Group A and Group B (*P > 0.05), suggesting a lack of statistical significance. However, the table also highlights a significant statistical difference in post-test values between Group A and Group B (***- P ≤ 0.001), indicating that there are meaningful distinctions between the two groups in terms of their post-test outcomes. The table provided presents the Mean, Standard Deviation (S.D), t-test results, degree of freedom (df), and p-values for the comparison of pre-test and post-test week data between Group A and Group B.The data from the table indicates that there isn't a significant distinction in pre-test values between Group A and Group B (*P > 0.05), implying a lack of statistically noteworthy variation. However, the table also indicates a statistically significant distinction in post-test values between Group A and Group B (***- P ≤ 0.001), suggesting that meaningful differences exist between the two groups regarding their post-test outcomes.

The Mean, Standard Deviation (S.D), t-value, and p-value between pre-test and post-test within Group A and Group B are presented in the provided table. A remarkably significant statistical difference is evident between the pre-test and post-test values within both Group A and Group B (***- P ≤ 0.001). The Mean, Standard Deviation (S.D), t-value,

and p-value between pre-test and post-test within Group A and Group B are displayed in the table above. Significantly high statistical differences exist between the pretest and posttest values within both Group A and Group B (***- P ≤ 0.001). When comparing the mean values of Cranio vertebral angle between Group A and Group B, there is a noteworthy increase in post-test mean values for both groups. Particularly, Group B (McKenzie exercise) demonstrates a higher mean value of 46.13, signifying its effectiveness compared to Group A (Muscle Energy Technique) with a mean value of 44.32, at a statistically significant level of P ≤ 0.001. As a result, the null hypothesis is rejected. Similarly, in the context of Neck Disability Index score, a substantial reduction in post-test mean values is observed for both Group A and Group B. Notably, Group B (McKenzie exercise) exhibits a lower mean value of 12.12, indicating its higher effectiveness in comparison to Group A (Muscle Energy Technique) with a mean value of 15.31, at a significance level of P ≤ 0.001. Consequently, the null hypothesis is rejected. Furthermore, upon examining the Pre-test and Post-test differences within Group A and Group B for both Cranio vertebral angle and Neck Disability Index Score, a highly significant disparity in mean values is evident at P ≤ 0.001.

DISCUSSION

Upper crossed syndrome is a prevalent postural abnormality seen in both the youthful and older generations. It mainly stems from extended periods of inadequate posture, resulting in rounded shoulders, a forward head stance, and a visible arch in the upper back and neck region [31]. This issue is also widespread among mothers who adapt their positions while nursing their infants. Utilizing a blend of stretching routines, targeted exercises, and deliberate postural corrections can serve as a proactive measure against the onset of upper crossed syndrome. This study represents the inaugural attempt to investigate the comparative efficacy of Muscle Energy Technique in contrast to McKenzie's exercises within the lactating female demographic. Muscle Energy Technique stands as an advanced stretching methodology that aids in the rehabilitation of debilitated muscles, concurrently offering pain mitigation. On the other hand, McKenzie's exercise regimen is a self-directed therapeutic approach, characterized by repetitive extensions. Its primary objective revolves around ameliorating musculoskeletal concerns, enhancing both posture and functionality, and curbing the reoccurrence of pain along with its attendant stress.

 The evaluation of forward head posture involved the measurement of the cranio vertebral angle, accomplished through the utilization of the ON Protractor app. Additionally, the degree of neck disability was gauged employing the Neck Disability Index, a scale comprised of ten sections where each item is assigned a score ranging from 0 to 5. The cumulative score obtained from this assessment can be doubled to yield a percentage score. The cranio vertebral angle and the score from the Neck Disability Index were both measured prior to and following the intervention, encompassing pre-test and post-test evaluations. A cohort of 30 participants was divided into two groups: Group A (consisting of n=15) and Group B (also consisting of n=15). In Group A, the intervention involved Muscle Energy Technique sessions conducted over a span of 5 weeks. These sessions encompassed a single set of 5 repetitions, scheduled for 3 sessions per week on alternate days. Meanwhile, Group B underwent McKenzie's exercises for a duration of 20 minutes daily, 3 times a week, over a period of 5 weeks. Notably, both groups were exposed to Janda's approach, encompassing a combination of strengthening and stretching exercises. As reported by Sajjad Ali et al. in 2017, their study concluded that Muscle Energy Technique (MET) has demonstrated considerable effectiveness, particularly when employing Post-Isometric Relaxation (PIR) and Proprioceptive Facilitation Stretching (PFS) techniques. These techniques were found to be beneficial in addressing issues such as hypertonicity, dysfunctional joint mechanics, and the subsequent heightened activity of mechanoreceptors associated with these conditions [32].

As indicated by Kostopolos et al. in 2008, their study yielded the conclusion that passive stretching exhibited a lesser degree of effectiveness in comparison to Muscle Energy Technique (MET). The research favored the utilization of MET in cases of mechanical neck pain. The study further demonstrated that MET led to a significant reduction in neck pain and notable enhancements in neck function [33]. Nevertheless, it's important to note that not all literature supports the assertion that Muscle Energy Technique (MET) is superior to conventional stretching methods. A study by Shenouda et al. in 2012 directly compared MET with stretching and arrived at a different conclusion. Their

research indicated that neither approach exhibited clear superiority over the other, implying that both strategies were comparable in terms of effectiveness [34]. As per the findings of Seyoon Kim et al. in 2019, their investigation into the impact of McKenzie exercises on forward head posture led to several conclusions. They reported that implementing McKenzie exercises over a span of 4 weeks led to notable enhancements in the Cranio vertebral angle. Specifically, the angle improved from 46.00° before commencing the exercises to 51.14° following the exercise regimen. The study also indicated that McKenzie exercises had the capacity to rectify abnormal posture and potentially accelerate the timeline towards achieving postural improvement [35]. The study conducted by Aguilar-Ferrándiz et al. in 2019, aimed to assess the immediate impacts of a single session of McKenzie exercises on individuals afflicted with upper crossed syndrome. The outcomes of the study demonstrated that participants who engaged in the McKenzie exercises exhibited positive changes in their posture and experienced a decrease in pain levels, in contrast to a control group [36]. Following a duration of 5 weeks of intervention, the present study's conclusion was derived through rigorous data analysis. The statistical analysis revealed significant effects in Group B, where McKenzie's exercise was employed, with a significance level of $P \leq 0.001$. As a result, the null hypothesis was rejected based on these findings. Muscle Energy Technique (MET) functions by enhancing the function of the musculoskeletal system through joint mobilization and the stretching of tense muscles and fascia. This approach aims to alleviate pain, facilitate improved circulation, and enhance the flow of lymphatic fluid. MET achieves these effects by inducing relaxation in specific muscles or muscle groups. This relaxation addresses heightened muscle tension, which is often associated with pain and restricted mobility in certain areas or joints. This process involves two fundamental mechanisms namely Post-Isometric Relaxation which involves reducing tension in an agonist muscle following isometric contraction. This relaxation helps alleviate pain and stiffness associated with the muscle. In Reciprocal Inhibition, the tone of an antagonist muscle decreases after the isometric contraction of its corresponding agonist muscle. This contributes to improved muscle tension, leading to pain relief and increased range of motion. The McKenzie exercise regimen employs techniques that apply controlled loading to address the adaptive muscle shortening in the neck area, which can lead to uncomfortable restrictions in movement and diminished spinal mobility. This therapeutic approach proves particularly effective as it leverages the patient's own force in a direction that alleviates chronic neck pain symptoms. Serving as an active therapeutic method, it encompasses an educational element and involves repeated movements or sustained positions.

These actions collectively work to reduce pain and disability while enhancing spinal mobility, all while minimizing movement constraints attributed to kinesiophobia. Additionally, the McKenzie exercise methodology is tailored to tackle musculoskeletal issues through the enhancement of posture and functionality. Its overarching objective is to mitigate pain recurrence and the associated stress, thereby offering a comprehensive approach to addressing these concerns [37]. Both the Muscle Energy Technique and a combination of McKenzie Exercise and Janda's Approach show potential in managing Upper Crossed Syndrome among lactating women. MET offers precise muscle targeting and immediate effects, but may demand more therapist involvement. On the other hand, the combination of McKenzie Exercise and Janda's Approach provides a more accessible, patient-centered approach that can be easily integrated into daily routines. However, further research is needed to establish the superiority of one approach over the other in this specific population. A personalized approach considering the patient's preferences, therapist expertise, and available resources will likely yield the best outcomes.

MET targets specific muscles through resisted contractions, providing direct neuromuscular input to restore balance. It requires skilled therapists to accurately apply the technique based on each individual's needs. MET involves active participation of the patient in muscle contractions against resistance. Research supporting the effectiveness of MET for UCS management is limited but promising. McKenzie and Janda's approach target overall muscle imbalances, addressing both weakened and tight muscles through exercises and stretches. It offers a more generalized set of exercises, making it easier for patients to perform them independently. McKenzie and Janda's approach rely on the patient's active participation in performing exercises and stretches. Studies on McKenzie exercises and Janda's Approach show positive results in improving posture and reducing pain, especially when combined. They may have an advantage in promoting self-management and long-term adherence due to the ease of performing exercises without specialized assistance. Nonetheless, the study's outcome indicated that the

effectiveness of McKenzie exercises surpassed that of Muscle Energy Technique in managing Upper Crossed syndrome within lactating women. The present study concluded that both the Muscle Energy Technique and McKenzie exercise demonstrate a significant increase in the Cranio vertebral angle, as well as a reduction in mechanical pain and neck disability in individuals with Upper Crossed Syndrome, specifically among lactating women. However, notable improvements are observed in GROUP B, which undergoes McKenzie exercises. The findings of this comparative study suggest that McKenzie exercises are more effective than the Muscle Energy Technique in addressing Upper Crossed Syndrome among lactating women.

ACKNOWLEDGEMENT

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Table-1Comparisonof Cranio vertebral Angle Between Group – A And Group - Bin Pre and Post Test

TEST	GROUP – A		GROUP - B		t - TEST	df	SIGNIFICANCE
	MEAN	S. D	MEAN	S. D			
PRE TEST	42.55	2.58	42.23	2.13	0.369	28	0.714*
POST TEST	44.32	2.03	46.13	2.11	-2.39	28	.000***

(*- P > 0.05), (*- P ≤ 0.001)**

Table – 2Comparisonof Neck Disability Index Score Between Group – A and Group - Bin Pre and Post Test

TEST	GROUP – A		GROUP - B		t - TEST	df	SIGNIFICANCE
	MEAN	S. D	MEAN	S. D			
PRE TEST	18.28	4.61	18.15	3.28	0.082	28	0.934*
POST TEST	15.31	4.16	12.12	3.31	2.32	28	.000***

(*- P > 0.05), (*- P ≤ 0.001)**

Table -3Comparisonof Cranio vertebral Anglewithin Group – A and Group - Bbetween Pre-Test and Post Test

GROUP	PRE-TEST		POST-TEST		t - TEST	SIGNIFICANCE
	MEAN	S. D	MEAN	S. D		
GROUP- A	42.55	2.58	44.32	2.03	-6.52	.000***
GROUP- B	42.23	2.13	46.13	2.11	-13.57	.000***

(*- P ≤ 0.001)**

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Table – 4Comparisonof Neck Disability Index Score within Group – A and Group – B Between Pre and Post Test

GROUP	PRE-TEST		POST-TEST		t - TEST	SIGNIFICANCE
	MEAN	S. D	MEAN	S. D		
GROUP- A	18.28	4.61	15.31	4.16	9.22	.000***
GROUP- B	18.15	3.28	12.12	3.31	14.78	.000***

(*- P ≤ 0.001)**

Fig. 1 Trapezius Stretching

Fig. 2 Levator Scapulae Stretching

Fig. 3Pectoralis muscle (Clavicular division) Stretching

Fig. 4Pectoralis muscle (Sternal division) Stretching

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Fig. 5 Chin tucks

Fig. 6 Neck Retraction and Extension

Fig. 7 Side Bending Exercise

Fig. 8 Neck Rotation

Fig. 9 Neck Flexion

Fig. 10 Shoulder Shrugs

Fig. 11 Levator scapulae stretch

Fig. 12 Upper Trapezius Stretch

Fig. 13 Pectoralis doorway stretch

Fig. 14 Towel Chest Stretch

Fig.15 Serratus Anterior wall slides

Fig.16TablePush– Upper Trapezius

Fig.17IsometricContraction Infraspinatus

Fig. 18 Rhomboid Muscle   Strengthening

Fig.19MiddleTrapezius Strengthening

Fig.20 Deep Neck Flexors Strengthening

Graph 1 Comparison of Cranio vertebral Angle between Group - A And Group - Bin Pre and Post Test

Graph 2 Comparison of Neck Disability Index Score Between Group – A and Group - Bin Pre and Post Test

Graph 3 Comparison of Cranio vertebral Anglewithin Group – A and Group – B between Pre-Test and Post Test

Graph 4 Comparisonof Neck Disability Index Score within Group – A and Group – B between Pre and Post Test

RESEARCH ARTICLE

Irregularity Indices for Thiophene-based Covalent Triazine Framework

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ABSTRACT

An expanding topic of research in the fields of computational and theoretical chemistry is the structural characterization of molecular compounds. Such assessment of the molecular structure and fundamental connectivity results in molecular descriptors, also known as topological indices, which are intended to forecast chemical characteristics and bioactivities. The topological indices also have a significant impact on the research exploring quantitative structure-activity relationships (QSAR) and quantitative structure-property relationships (QSPR), which correlate a chemical structure to its properties. Irregularity indices have the potential to quantitatively characterize the topological properties of non-regular graphs. In recent decades, 2-D covalent organic frameworks (COFs) are getting prominence due to their predictable topologies and organized nanopores. In this study, we computed certain degree-based irregularity measures of thiophene-based covalent triazine framework (TBCTF). We also compared our results graphically.

Keywords: Covalent organic framework, irregularity indices, topological index, molecular graph.

INTRODUCTION

By employing graphs, we can analyze molecular structures. As a subfield of mathematics, chemical graph theory focuses on the analysis of chemical graphs. A specific category of chemical graphs known as molecular graphs describes the topology of molecules [1,2]. Let $\Theta = \left(\Upsilon(\Theta), \; \dagger(\Theta) \right)$ denotes a molecular graph with order η (number of nodes) and size τ (number of links). The notation $\hbar \xi$ is adapted for the link joining the nodes $\hbar$ and ξ. The

symbol $\lambda_\hbar$ denotes the degree of $\hbar$ (*ie.*, $\hbar \in \Upsilon(\Theta)$), which is the number of nodes that are neighbor to $\hbar$ [3,4]. This article considers molecular graphs that are connected, loopless, finite, undirected and without multiple links. The topological indices often referred to as structural descriptors that have the ability to predict the physicochemical properties, are one of the most important aspects of QSAR/QSPR modeling [5-7]. The topological indices have started to emerge as essential descriptors in the field of molecular chemistry and chemical graph theory due to their simplicity in usage compared to the use of numerically intense quantum chemical computations. The activity of molecular compounds heavily relies on their structures and the relationship of molecular structure dependency can be quantitatively symbolized by P = g (M), where P denotes the specific property and M represents the molecular structure [8]. The wiener index was the first structural descriptor used in biology and chemistry in 1947, when chemist Wiener [9] established it for investigating boiling points of alkanes. The degree-based topological indices employed in mathematical chemistry are defined on the basis of the degree of the node of a graph. The first genuine degree-based structural descriptor is Randić index (branching index) which was introduced by Milan Randić in 1975 [10]. Due to the extensive use of the Randić index, the generalised Randić index was developed Bollobas and Erdos [11].

Randić index $R = \displaystyle\sum_{\hbar\xi \in \dagger(\Theta)} \frac{1}{\sqrt{\lambda_\hbar \, \lambda_\xi}}$

Amic *et al.*[12] have defined an important molecular descriptor known as reciprocal Randic index, which is given by

$$RR = \sum_{\hbar\xi \in \dagger(\Theta)} \sqrt{\lambda_\hbar \, \lambda_\xi}$$

After that, a pair of degree-based Zagreb indices were introduced by Gutman *et al.* [13], which are defined below,

$$M_1 = \sum_{\hbar\xi \in \dagger(\Theta)} \left(\lambda_\hbar + \lambda_\xi\right) = \sum_{\hbar \in \Upsilon(\Theta)} \lambda_\hbar^2$$

$$M_2 = \sum_{\hbar\xi \in \dagger(\Theta)} \left(\lambda_\hbar \, \lambda_\xi\right)$$

Then, Furtula *et al.*[14] investigated the Forgotten index for certain chemical networks.

$$F = \sum_{\hbar\xi \in \dagger(\Theta)} \left(\lambda_\hbar^2 + \lambda_\xi^2\right) = \sum_{\hbar \in \Upsilon(\Theta)} \lambda_\hbar^3$$

Cote et al. [15] proposed the COFs as a novel class of organic porous crystalline polymers with nature. Long-range ordered crystalline frameworks can be formed thanks to the COFs' capacity for thermodynamically controlled covalent bonding and self-heating. Superior chemical stability in organic solvents is a crucial characteristic of COFs. Owing to their metal-free architectures and pure covalent bonding, COFs have a high degree of stability. Large pores distinguish COFs from other porous silicas and inorganic zoelites. This characteristic of COFs can be useful in catalysis, where large pores accelerate reactant diffusion and product desorption, improving selectivity and yield [16]. Numerous frameworks such as hexagonal, chain silicate, honeycomb, silicate and oxide networks are similar to the systems of chemical/atomic structure. Such networks have certain distinctive properties that are quite significant. Their applications are greatly influenced by their structural characteristics. Characterization of the various properties of these frameworks is urgently required to address the growing demands of the materials for future nanotechnology. In this article, we exclusively focus on the computation of irregularity indices of TBCTF network.

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Preliminaries

A numerical quantity related with a graph that reflects the irregularity of the graph is called an irregularity index. An irregularity index is a more concise approach to represent the irregularity. Moreover, the development of irregular indices relies on the transformation of a molecular graph into a total number that captures the irregularity of the molecular arrangement on the map [21].

The topological index
$$\mathrm{TI}(\Theta) = \begin{cases} \text{non-negative,} & \Theta \text{ is irregular} \\ 0, & \Theta \text{ is regular} \end{cases}.$$

Albertson [18] coined the phrase "irregularity of a graph Θ " in 1997. This variant is represented by $A(\Theta)$. Another name for this invariant is the third Zagreb index. He demonstrated that "the irregularity of any graph is an even number". Additionally, he investigated upper bounds for bipartite graphs, triangle-free graphs and the irregularity of trees. In [22], it was investigated how irregularity of unicyclic graphs and matching number and trees relate to one another. Hansen et al. [23] defined the graphs with the highest degree of irregularity. The irregularity of graph operations was calculated by Abdo and Dimitrov [24]. Abdo et al. [25] described the total irregularity measure of a graph Θ in 2014. The irregularity measures of several chemical structures were studied in [26–29]. The degree-based irregularity indices that will be needed to calculate our main results are displayed in Table 1. We apply graph-theoretical tools, link partition techniques, analytical methods, degree counting methods and combinatorial computation techniques for obtaining our primary findings. GNU-OCTAVE v.5.2.0 software is employed for 3-D surface mapping.

RESULTS AND DISCUSSIONS

In this section, we discuss about the topological aspects of TBCTF network and also compute the irregularity indices for each network.

Topological characteristics of TBCTF

A family of organic polymers with well defined structure and persistent porosity is known as COFs. The feature that COFs are synthetically modifiable, geometrically pre designable and functionally accessible is a crucial characteristic. COFs typically contain lightweight components including C, N, B, O, H and Si, which contributes to their low mass density [30]. In order to facilitate the selective oxidation of alcohols into the appropriate ketones and aldehydes under the influence of visible light, Huang et al. [31] proposed TBCTF as illustrated in Fig. 2. Thiophene and triazine are the two building blocks that make up the unit cell of TBCTF. The purpose of band gap engineering is to utilize constitutional isomers of TBCTF. We reserve the symbol $\Theta_1(\varsigma, \alpha)$ for the molecular graph of TBCTF, where ς represents the number of fundamental units in every row and α indicates the number of fundamental units in every column. A basic computation reveals that $\Theta_1(\varsigma, \alpha)$ contains $33\varsigma\alpha$ nodes and $39\varsigma\alpha - \varsigma - \alpha$ links.

Theorem 3.1 If the molecular graph $\Theta_1(\varsigma, \alpha)$ symbolizes the TBCTF, then

(1) $\mathrm{B}(\Theta_1(\varsigma, \alpha)) = \frac{648\varsigma^2\alpha^2 - 18(\varsigma^2\alpha + \varsigma\alpha^2) - 4(\varsigma^2 + \alpha^2) - 8\varsigma\alpha}{1089\varsigma^2\alpha^2}.$

(2) $\mathrm{A}(\Theta_1(\varsigma, \alpha)) = 30\varsigma\alpha - 2(\varsigma + \alpha).$

(3) $\mathrm{IR1}(\Theta_1(\varsigma, \alpha)) = \frac{2700\varsigma^2\alpha^2 - 66(\varsigma^2\alpha + \varsigma\alpha^2) - 40\varsigma\alpha - 20(\varsigma^2 + \alpha^2)}{33\varsigma\alpha}.$

(4) $\mathrm{IR2}(\Theta_1(\varsigma, \alpha)) = \sqrt{\frac{261\varsigma\alpha - 18(\varsigma + \alpha)}{39\varsigma\alpha - (\varsigma + \alpha)}} - \left(\frac{78\varsigma\alpha - 2(\varsigma + \alpha)}{33\varsigma\alpha}\right).$

(5) $\mathrm{IRF}(\Theta_1(\varsigma, \alpha)) = 42\varsigma\alpha - 2(\varsigma + \alpha).$

(6) $\text{IRFW}\left(\Theta_1(\varsigma,\alpha)\right)=\dfrac{42\varsigma\alpha-2(\varsigma+\alpha)}{261\varsigma\alpha-18(\varsigma+\alpha)}.$

(7) $\text{IRA}\left(\Theta_1(\varsigma,\alpha)\right)=\left(23-4\sqrt{3}-6\sqrt{6}\right)\varsigma\alpha-\left(\dfrac{5-2\sqrt{6}}{3}\right)(\varsigma+\alpha).$

(8) $\text{IRB}\left(\Theta_1(\varsigma,\alpha)\right)=\left(114-12\sqrt{3}-36\sqrt{6}\right)\varsigma\alpha-\left(10-4\sqrt{6}\right)(\varsigma+\alpha).$

(9) $\text{IRDIF}\left(\Theta_1(\varsigma,\alpha)\right)=\dfrac{93\varsigma\alpha-5(\varsigma+\alpha)}{3}.$

(10) $\text{IRLF}\left(\Theta_1(\varsigma,\alpha)\right)=\left(4\sqrt{3}+3\sqrt{6}\right)\varsigma\alpha-\sqrt{\dfrac{2}{3}}(\varsigma+\alpha).$

(11) $\text{IRLA}\left(\Theta_1(\varsigma,\alpha)\right)=\dfrac{66\varsigma\alpha-4(\varsigma+\alpha)}{5}.$

(12) $\text{IRDI}\left(\Theta_1(\varsigma,\alpha)\right)=\left(6\ln3+18\ln2\right)\varsigma\alpha-2\ln2(\varsigma+\alpha).$

(13) $\text{IRGA}\left(\Theta_1(\varsigma,\alpha)\right)=\left[6\ln\left(\dfrac{2}{\sqrt{3}}\right)+18\ln\left(\dfrac{5}{2\sqrt{6}}\right)\right]\varsigma\alpha-2\ln\left(\dfrac{5}{2\sqrt{6}}\right)(\varsigma+\alpha).$

Proof: By employing the formulas in Table 1 and the data supplied in Table 2, we could compute the following expressions.

(1) $\text{B}\left(\Theta_1(\varsigma,\alpha)\right)=\displaystyle\sum_{\hbar\in\Upsilon\left(\Theta_1(\varsigma,\alpha)\right)}\left(\lambda_\hbar-\dfrac{2\tau}{\eta}\right)^2=\dfrac{M_1\left(\Theta_1(\varsigma,\alpha)\right)}{\eta}-\left(\dfrac{2\tau}{\eta}\right)^2.$

$=\dfrac{1}{33\varsigma\alpha}\left[\displaystyle\sum_{\hbar\xi\in\dagger_{(1,3)}\left(\Theta_1(\varsigma,\alpha)\right)}\left(\lambda_\hbar+\lambda_\xi\right)+\sum_{\hbar\xi\in\dagger_{(2,2)}\left(\Theta_1(\varsigma,\alpha)\right)}\left(\lambda_\hbar+\lambda_\xi\right)+\sum_{\hbar\xi\in\dagger_{(2,3)}\left(\Theta_1(\varsigma,\alpha)\right)}\left(\lambda_\hbar+\lambda_\xi\right)+\sum_{\hbar\xi\in\dagger_{(3,3)}\left(\Theta_1(\varsigma,\alpha)\right)}\left(\lambda_\hbar+\lambda_\xi\right)\right]-\left(\dfrac{78\varsigma\alpha-2\varsigma-2\alpha}{33\varsigma\alpha}\right)^2.$

$=\dfrac{1}{33\varsigma\alpha}\left[6\varsigma\alpha(4)+(3\varsigma+3\alpha)(4)+(18\varsigma\alpha-2\varsigma-2\alpha)(5)+(15\varsigma\alpha-2\varsigma-2\alpha)(6)\right]-\left(\dfrac{78\varsigma\alpha-2\varsigma-2\alpha}{33\varsigma\alpha}\right)^2.$

$=\dfrac{204\varsigma\alpha-10\varsigma-10\alpha}{33\varsigma\alpha}-\left(\dfrac{78\varsigma\alpha-2\varsigma-2\alpha}{33\varsigma\alpha}\right)^2=\dfrac{648\varsigma^2\alpha^2-18\left(\varsigma^2\alpha+\varsigma\alpha^2\right)-4\left(\varsigma^2+\alpha^2\right)-8\varsigma\alpha}{1089\varsigma^2\alpha^2}.$

(2) $\text{A}\left(\Theta_1(\varsigma,\alpha)\right)=\displaystyle\sum_{\hbar\xi\in\dagger\left(\Theta_1(\varsigma,\alpha)\right)}\left|\lambda_\hbar-\lambda_\xi\right|$

$=\displaystyle\sum_{\hbar\xi\in\dagger_{(1,3)}\left(\Theta_1(\varsigma,\alpha)\right)}\left|\lambda_\hbar-\lambda_\xi\right|+\sum_{\hbar\xi\in\dagger_{(2,2)}\left(\Theta_1(\varsigma,\alpha)\right)}\left|\lambda_\hbar-\lambda_\xi\right|$

$+\displaystyle\sum_{\hbar\xi\in\dagger_{(2,3)}\left(\Theta_1(\varsigma,\alpha)\right)}\left|\lambda_\hbar-\lambda_\xi\right|+\sum_{\hbar\xi\in\dagger_{(3,3)}\left(\Theta_1(\varsigma,\alpha)\right)}\left|\lambda_\hbar-\lambda_\xi\right|.$

$=6\varsigma\alpha(2)+(3\varsigma+3\alpha)(0)+(18\varsigma\alpha-2\varsigma-2\alpha)(1)+(15\varsigma\alpha-2\varsigma-2\alpha)(0)=30\varsigma\alpha-2(\varsigma+\alpha).$

$$(3)\ \mathrm{IR1}\big(\Theta_1(\varsigma,\alpha)\big)= \sum_{\hbar\in\Upsilon(\Theta_1(\varsigma,\alpha))} \lambda_\hbar^3 - \frac{2\tau}{\eta}\sum_{\hbar\in\Upsilon(\Theta_1(\varsigma,\alpha))}\lambda_\hbar^2$$

$$= F\big(\Theta_1(\varsigma,\alpha)\big)-\frac{2\tau}{\eta}M_1\big(\Theta_1(\varsigma,\alpha)\big).$$

$$=\left[\sum_{\hbar\xi\in\dagger_{(1,3)}(\Theta_1(\varsigma,\alpha))}\big(\lambda_\hbar^2+\lambda_\xi^2\big)+\sum_{\hbar\xi\in\dagger_{(2,2)}(\Theta_1(\varsigma,\alpha))}\big(\lambda_\hbar^2+\lambda_\xi^2\big)\right.$$
$$\left.+\sum_{\hbar\xi\in\dagger_{(2,3)}(\Theta_1(\varsigma,\alpha))}\big(\lambda_\hbar^2+\lambda_\xi^2\big)+\sum_{\hbar\xi\in\dagger_{(3,3)}(\Theta_1(\varsigma,\alpha))}\big(\lambda_\hbar^2+\lambda_\xi^2\big)\right]$$

$$-\left(\frac{78\varsigma\alpha-2\varsigma-2\alpha}{33\varsigma\alpha}\right)\left[\sum_{\hbar\xi\in\dagger_{(1,3)}(\Theta_1(\varsigma,\alpha))}\big(\lambda_\hbar+\lambda_\xi\big)+\sum_{\hbar\xi\in\dagger_{(2,2)}(\Theta_1(\varsigma,\alpha))}\big(\lambda_\hbar+\lambda_\xi\big)\right.$$
$$\left.+\sum_{\hbar\xi\in\dagger_{(2,3)}(\Theta_1(\varsigma,\alpha))}\big(\lambda_\hbar+\lambda_\xi\big)+\sum_{\hbar\xi\in\dagger_{(3,3)}(\Theta_1(\varsigma,\alpha))}\big(\lambda_\hbar+\lambda_\xi\big)\right].$$

$$=\big[6\varsigma\alpha(10)+(3\varsigma+3\alpha)(8)+(18\varsigma\alpha-2\varsigma-2\alpha)(13)+(15\varsigma\alpha-2\varsigma-2\alpha)(18)\big]$$

$$-\left(\frac{78\varsigma\alpha-2\varsigma-2\alpha}{33\varsigma\alpha}\right)\big[6\varsigma\alpha(4)+(3\varsigma+3\alpha)(4)+(18\varsigma\alpha-2\varsigma-2\alpha)(5)+(15\varsigma\alpha-2\varsigma-2\alpha)(6)\big].$$

$$=(564\varsigma\alpha-38\varsigma-38\alpha)-\left(\frac{78\varsigma\alpha-2\varsigma-2\alpha}{33\varsigma\alpha}\right)(204\varsigma\alpha-10\varsigma-10\alpha).$$

$$=\frac{2700\varsigma^2\alpha^2-66\big(\varsigma^2\alpha+\varsigma\alpha^2\big)-40\varsigma\alpha-20\big(\varsigma^2+\alpha^2\big)}{33\varsigma\alpha}.$$

$$(4)\ \mathrm{IR2}\big(\Theta_1(\varsigma,\alpha)\big)=\sqrt{\frac{\sum_{\hbar\xi\in\dagger(\Theta_1(\varsigma,\alpha))}\big(\lambda_\hbar\lambda_\xi\big)}{\tau}}-\frac{2\tau}{\eta}=\sqrt{\frac{M_2\big(\Theta_1(\varsigma,\alpha)\big)}{\tau}}-\frac{2\tau}{\eta}.$$

$$=\frac{1}{\sqrt{39\varsigma\alpha-\varsigma-\alpha}}\left[\sum_{\hbar\xi\in\dagger_{(1,3)}(\Theta_1(\varsigma,\alpha))}\big(\lambda_\hbar\lambda_\xi\big)+\sum_{\hbar\xi\in\dagger_{(2,2)}(\Theta_1(\varsigma,\alpha))}\big(\lambda_\hbar\lambda_\xi\big)\right.$$
$$\left.+\sum_{\hbar\xi\in\dagger_{(2,3)}(\Theta_1(\varsigma,\alpha))}\big(\lambda_\hbar\lambda_\xi\big)+\sum_{\hbar\xi\in\dagger_{(3,3)}(\Theta_1(\varsigma,\alpha))}\big(\lambda_\hbar\lambda_\xi\big)\right]^{\frac{1}{2}}$$

$$-\left(\frac{78\varsigma\alpha-2\varsigma-2\alpha}{33\varsigma\alpha}\right).$$

$$=\sqrt{\frac{6\varsigma\alpha(3)+(3\varsigma+3\alpha)(4)+(18\varsigma\alpha-2\varsigma-2\alpha)(6)+(15\varsigma\alpha-2\varsigma-2\alpha)(9)}{39\varsigma\alpha-\varsigma-\alpha}}-\left(\frac{78\varsigma\alpha-2\varsigma-2\alpha}{33\varsigma\alpha}\right).$$

$$=\sqrt{\frac{261\varsigma\alpha-18(\varsigma+\alpha)}{39\varsigma\alpha-(\varsigma+\alpha)}}-\left(\frac{78\varsigma\alpha-2(\varsigma+\alpha)}{33\varsigma\alpha}\right).$$

(5) $\text{IRF}\left(\Theta_1\left(\varsigma,\alpha\right)\right)= \sum_{\hbar\xi\in\dagger\left(\Theta_1\left(\varsigma,\alpha\right)\right)}\left(\lambdaslash_\hbar - \lambdaslash_\xi\right)^2 = F\left(\Theta_1\left(\varsigma,\alpha\right)\right)-2M_2\left(\Theta_1\left(\varsigma,\alpha\right)\right).$

$$= 564\varsigma\alpha - 38\varsigma - 38\alpha - 2\left(261\varsigma\alpha - 18\varsigma - 18\alpha\right) = 42\varsigma\alpha - 2\left(\varsigma+\alpha\right).$$

(6) $\text{IRFW}\left(\Theta_1\left(\varsigma,\alpha\right)\right)= \dfrac{IRF\left(\Theta_1\left(\varsigma,\alpha\right)\right)}{\displaystyle\sum_{\hbar\xi\in\dagger\left(\Theta_1\left(\varsigma,\alpha\right)\right)}\left(\lambdaslash_\hbar\,\lambdaslash_\xi\right)} = \dfrac{IRF\left(\Theta_1\left(\varsigma,\alpha\right)\right)}{M_2\left(\Theta_1\left(\varsigma,\alpha\right)\right)}.$

$$= \dfrac{42\varsigma\alpha - 2\left(\varsigma+\alpha\right)}{261\varsigma\alpha - 18\left(\varsigma+\alpha\right)}.$$

(7) $\text{IRA}\left(\Theta_1\left(\varsigma,\alpha\right)\right)= \sum_{\hbar\xi\in\dagger\left(\Theta_1\left(\varsigma,\alpha\right)\right)}\left(\lambdaslash_\hbar^{\frac{-1}{2}} - \lambdaslash_\xi^{\frac{-1}{2}}\right)^2 = \eta - 2R\left(\Theta_1\left(\varsigma,\alpha\right)\right).$

$$= 33\varsigma\alpha - 2\left[\sum_{\hbar\xi\in\dagger_{(1,3)}\left(\Theta_1(\varsigma,\alpha)\right)}\frac{1}{\sqrt{\lambdaslash_\hbar\,\lambdaslash_\xi}} + \sum_{\hbar\xi\in\dagger_{(2,2)}\left(\Theta_1(\varsigma,\alpha)\right)}\frac{1}{\sqrt{\lambdaslash_\hbar\,\lambdaslash_\xi}} + \sum_{\hbar\xi\in\dagger_{(2,3)}\left(\Theta_1(\varsigma,\alpha)\right)}\frac{1}{\sqrt{\lambdaslash_\hbar\,\lambdaslash_\xi}} + \sum_{\hbar\xi\in\dagger_{(3,3)}\left(\Theta_1(\varsigma,\alpha)\right)}\frac{1}{\sqrt{\lambdaslash_\hbar\,\lambdaslash_\xi}} \right]$$

$$= 33\varsigma\alpha - 2\left[\frac{6\varsigma\alpha}{\sqrt{3}} + \frac{3\varsigma+3\alpha}{2} + \frac{18\varsigma\alpha - 2\varsigma - 2\alpha}{\sqrt{6}} + \frac{15\varsigma\alpha - 2\varsigma - 2\alpha}{3} \right]$$

$$= \left(23 - 4\sqrt{3} - 6\sqrt{6}\right)\varsigma\alpha - \left(\frac{5 - 2\sqrt{6}}{3}\right)\left(\varsigma+\alpha\right).$$

(8) $\text{IRB}\left(\Theta_1\left(\varsigma,\alpha\right)\right)= \sum_{\hbar\xi\in\dagger\left(\Theta_1\left(\varsigma,\alpha\right)\right)}\left(\lambdaslash_\hbar^{\frac{1}{2}} - \lambdaslash_\xi^{\frac{1}{2}}\right)^2 = M_1\left(\Theta_1\left(\varsigma,\alpha\right)\right)-2RR\left(\Theta_1\left(\varsigma,\alpha\right)\right).$

$$= \left[\sum_{\hbar\xi\in\dagger_{(1,3)}\left(\Theta_1(\varsigma,\alpha)\right)}\left(\lambdaslash_\hbar + \lambdaslash_\xi\right) + \sum_{\hbar\xi\in\dagger_{(2,2)}\left(\Theta_1(\varsigma,\alpha)\right)}\left(\lambdaslash_\hbar + \lambdaslash_\xi\right) + \sum_{\hbar\xi\in\dagger_{(2,3)}\left(\Theta_1(\varsigma,\alpha)\right)}\left(\lambdaslash_\hbar + \lambdaslash_\xi\right) + \sum_{\hbar\xi\in\dagger_{(3,3)}\left(\Theta_1(\varsigma,\alpha)\right)}\left(\lambdaslash_\hbar + \lambdaslash_\xi\right) \right]$$

$$- 2\left[\sum_{\hbar\xi\in\dagger_{(1,3)}\left(\Theta_1(\varsigma,\alpha)\right)}\sqrt{\lambdaslash_\hbar\,\lambdaslash_\xi} + \sum_{\hbar\xi\in\dagger_{(2,2)}\left(\Theta_1(\varsigma,\alpha)\right)}\sqrt{\lambdaslash_\hbar\,\lambdaslash_\xi} + \sum_{\hbar\xi\in\dagger_{(2,3)}\left(\Theta_1(\varsigma,\alpha)\right)}\sqrt{\lambdaslash_\hbar\,\lambdaslash_\xi} + \sum_{\hbar\xi\in\dagger_{(3,3)}\left(\Theta_1(\varsigma,\alpha)\right)}\sqrt{\lambdaslash_\hbar\,\lambdaslash_\xi} \right]$$

$$= 6\varsigma\alpha\left(4\right)+\left(3\varsigma+3\alpha\right)\left(4\right)+\left(18\varsigma\alpha - 2\varsigma - 2\alpha\right)\left(5\right)+\left(15\varsigma\alpha - 2\varsigma - 2\alpha\right)\left(6\right)$$

$$- 2\left[6\sqrt{3}\varsigma\alpha + \left(3\varsigma+3\alpha\right)\left(2\right)+\left(18\varsigma\alpha - 2\varsigma - 2\alpha\right)\left(\sqrt{6}\right)+\left(15\varsigma\alpha - 2\varsigma - 2\alpha\right)\left(3\right) \right]$$

$$= 204\varsigma\alpha - 10\varsigma - 10\alpha - 2\left[\left(45 + 6\sqrt{3} + 18\sqrt{6}\right)\varsigma\alpha - 2\sqrt{6}\varsigma - 2\sqrt{6}\alpha\right]$$

$$= \left(114 - 12\sqrt{3} - 36\sqrt{6}\right)\varsigma\alpha - \left(10 - 4\sqrt{6}\right)(\varsigma + \alpha).$$

$$(9)\ \text{IRDIF}\left(\Theta_1(\varsigma,\alpha)\right) = \sum_{\hbar\xi \in \dagger\left(\Theta_1(\varsigma,\alpha)\right)} \left|\frac{\lambda_\hbar}{\lambda_\xi} - \frac{\lambda_\xi}{\lambda_\hbar}\right| = \sum_{\hbar\xi \in \dagger\left(\Theta_1(\varsigma,\alpha)\right)} \left|\frac{\lambda_\hbar^2 - \lambda_\xi^2}{\lambda_\hbar\ \lambda_\xi}\right|.$$

$$= \sum_{\hbar\xi \in \dagger_{(1,3)}\left(\Theta_1(\varsigma,\alpha)\right)} \left|\frac{\lambda_\hbar^2 - \lambda_\xi^2}{\lambda_\hbar\ \lambda_\xi}\right| + \sum_{\hbar\xi \in \dagger_{(2,2)}\left(\Theta_1(\varsigma,\alpha)\right)} \left|\frac{\lambda_\hbar^2 - \lambda_\xi^2}{\lambda_\hbar\ \lambda_\xi}\right|$$

$$+ \sum_{\hbar\xi \in \dagger_{(2,3)}\left(\Theta_1(\varsigma,\alpha)\right)} \left|\frac{\lambda_\hbar^2 - \lambda_\xi^2}{\lambda_\hbar\ \lambda_\xi}\right| + \sum_{\hbar\xi \in \dagger_{(3,3)}\left(\Theta_1(\varsigma,\alpha)\right)} \left|\frac{\lambda_\hbar^2 - \lambda_\xi^2}{\lambda_\hbar\ \lambda_\xi}\right|$$

$$= 6\varsigma\alpha\left(\frac{8}{3}\right) + (3\varsigma + 3\alpha)\left(\frac{0}{4}\right) + (18\varsigma\alpha - 2\varsigma - 2\alpha)\left(\frac{5}{6}\right) + (15\varsigma\alpha - 2\varsigma - 2\alpha)\left(\frac{0}{9}\right) = \frac{93\varsigma\alpha - 5(\varsigma + \alpha)}{3}.$$

$$(10)\ \text{IRLF}\left(\Theta_1(\varsigma,\alpha)\right) = \sum_{\hbar\xi \in \dagger\left(\Theta_1(\varsigma,\alpha)\right)} \frac{\left|\lambda_\hbar - \lambda_\xi\right|}{\sqrt{\lambda_\hbar\ \lambda_\xi}}.$$

$$= \sum_{\hbar\xi \in \dagger_{(1,3)}\left(\Theta_1(\varsigma,\alpha)\right)} \frac{\left|\lambda_\hbar - \lambda_\xi\right|}{\sqrt{\lambda_\hbar\ \lambda_\xi}} + \sum_{\hbar\xi \in \dagger_{(2,2)}\left(\Theta_1(\varsigma,\alpha)\right)} \frac{\left|\lambda_\hbar - \lambda_\xi\right|}{\sqrt{\lambda_\hbar\ \lambda_\xi}}$$

$$+ \sum_{\hbar\xi \in \dagger_{(2,3)}\left(\Theta_1(\varsigma,\alpha)\right)} \frac{\left|\lambda_\hbar - \lambda_\xi\right|}{\sqrt{\lambda_\hbar\ \lambda_\xi}} + \sum_{\hbar\xi \in \dagger_{(3,3)}\left(\Theta_1(\varsigma,\alpha)\right)} \frac{\left|\lambda_\hbar - \lambda_\xi\right|}{\sqrt{\lambda_\hbar\ \lambda_\xi}}$$

$$= 6\varsigma\alpha\left(\frac{2}{\sqrt{3}}\right) + (3\varsigma + 3\alpha)\left(\frac{0}{2}\right) + (18\varsigma\alpha - 2\varsigma - 2\alpha)\left(\frac{1}{\sqrt{6}}\right) + (15\varsigma\alpha - 2\varsigma - 2\alpha)\left(\frac{0}{3}\right)$$

$$= \left(4\sqrt{3} + 3\sqrt{6}\right)\varsigma\alpha - \sqrt{\frac{2}{3}}(\varsigma + \alpha).$$

$$(11)\ \text{IRLA}\left(\Theta_1(\varsigma,\alpha)\right) = 2\sum_{\hbar\xi \in \dagger\left(\Theta_1(\varsigma,\alpha)\right)} \frac{\left|\lambda_\hbar - \lambda_\xi\right|}{\lambda_\hbar + \lambda_\xi}.$$

$$= 2\sum_{\hbar\xi \in \dagger_{(1,3)}\left(\Theta_1(\varsigma,\alpha)\right)} \frac{\left|\lambda_\hbar - \lambda_\xi\right|}{\lambda_\hbar + \lambda_\xi} + 2\sum_{\hbar\xi \in \dagger_{(2,2)}\left(\Theta_1(\varsigma,\alpha)\right)} \frac{\left|\lambda_\hbar - \lambda_\xi\right|}{\lambda_\hbar + \lambda_\xi} + 2\sum_{\hbar\xi \in \dagger_{(2,3)}\left(\Theta_1(\varsigma,\alpha)\right)} \frac{\left|\lambda_\hbar - \lambda_\xi\right|}{\lambda_\hbar + \lambda_\xi} + 2\sum_{\hbar\xi \in \dagger_{(3,3)}\left(\Theta_1(\varsigma,\alpha)\right)} \frac{\left|\lambda_\hbar - \lambda_\xi\right|}{\lambda_\hbar + \lambda_\xi}$$

$$= 2(6\varsigma\alpha)\left(\frac{2}{4}\right) + 2(3\varsigma + 3\alpha)\left(\frac{0}{4}\right) + 2(18\varsigma\alpha - 2\varsigma - 2\alpha)\left(\frac{1}{5}\right) + 2(15\varsigma\alpha - 2\varsigma - 2\alpha)\left(\frac{0}{6}\right) = \frac{66\varsigma\alpha - 4(\varsigma + \alpha)}{5}.$$

$$(12)\ \text{IRDI}\left(\Theta_1(\varsigma,\alpha)\right) = \sum_{\hbar\xi \in \dagger\left(\Theta_1(\varsigma,\alpha)\right)} ln\left(1 + \left|\lambda_\hbar - \lambda_\xi\right|\right).$$

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$$= \sum_{\hbar\xi \in \dagger_{(1,3)}(\Theta_1(\varsigma,\alpha))} ln\left(1+\left|\lambda_\hbar - \lambda_\xi\right|\right) + \sum_{\hbar\xi \in \dagger_{(2,2)}(\Theta_1(\varsigma,\alpha))} ln\left(1+\left|\lambda_\hbar - \lambda_\xi\right|\right)$$

$$+ \sum_{\hbar\xi \in \dagger_{(2,3)}(\Theta_1(\varsigma,\alpha))} ln\left(1+\left|\lambda_\hbar - \lambda_\xi\right|\right) + \sum_{\hbar\xi \in \dagger_{(3,3)}(\Theta_1(\varsigma,\alpha))} ln\left(1+\left|\lambda_\hbar - \lambda_\xi\right|\right).$$

$$= 6\varsigma\alpha\, ln(1+2)+(3\varsigma+3\alpha)ln(1+0)+(18\varsigma\alpha-2\varsigma-2\alpha)ln(1+1)+(15\varsigma\alpha-2\varsigma-2\alpha)ln(1+0)$$
$$= (6ln3+18ln2)\varsigma\alpha-2ln2(\varsigma+\alpha).$$

(13) $\text{IRGA}\left(\Theta_1(\varsigma,\alpha)\right) = \sum_{\hbar\xi \in \dagger(\Theta_1(\varsigma,\alpha))} ln\left(\frac{\left|\lambda_\hbar + \lambda_\xi\right|}{2\sqrt{\lambda_\hbar\,\lambda_\xi}}\right).$

$$= \sum_{\hbar\xi \in \dagger_{(1,3)}(\Theta_1(\varsigma,\alpha))} ln\left(\frac{\left|\lambda_\hbar + \lambda_\xi\right|}{2\sqrt{\lambda_\hbar\,\lambda_\xi}}\right) + \sum_{\hbar\xi \in \dagger_{(2,2)}(\Theta_1(\varsigma,\alpha))} ln\left(\frac{\left|\lambda_\hbar + \lambda_\xi\right|}{2\sqrt{\lambda_\hbar\,\lambda_\xi}}\right)$$

$$+ \sum_{\hbar\xi \in \dagger_{(2,3)}(\Theta_1(\varsigma,\alpha))} ln\left(\frac{\left|\lambda_\hbar + \lambda_\xi\right|}{2\sqrt{\lambda_\hbar\,\lambda_\xi}}\right) + \sum_{\hbar\xi \in \dagger_{(3,3)}(\Theta_1(\varsigma,\alpha))} ln\left(\frac{\left|\lambda_\hbar + \lambda_\xi\right|}{2\sqrt{\lambda_\hbar\,\lambda_\xi}}\right).$$

$$= 6\varsigma\alpha\, ln\left(\frac{2}{\sqrt{3}}\right)+(3\varsigma+3\alpha)ln\left(\frac{4}{4}\right)+(18\varsigma\alpha-2\varsigma-2\alpha)ln\left(\frac{5}{2\sqrt{6}}\right)+(15\varsigma\alpha-2\varsigma-2\alpha)ln\left(\frac{6}{6}\right)$$

$$= \left[6ln\left(\frac{2}{\sqrt{3}}\right)+18ln\left(\frac{5}{2\sqrt{6}}\right)\right]\varsigma\alpha-2ln\left(\frac{5}{2\sqrt{6}}\right)(\varsigma+\alpha).$$

Figure 2 and Figure 3 show the 3-D surface plots of various irregularity indices. It is worth mentioning that, the IR1(Θ_1) index exhibits the highest response in relation to the structural complexity of TBCTF network. Whereas, the B(Θ_1), IR2(Θ_1), and IRFW(Θ_1) indices would be less responsive to the lattice irregularity.

CONCLUSION

In this research, we computed accurate expressions for some irregularity indices of TBCTF network. We also present a comparative analysis of such indices using graph structures. When compared to other indices, the IR1 index has relatively high prediction capability for determining the structural irregularity of those networks. These insights have been advantageous and helpful in comprehending the difficult irregular nature of such lattices and could possibly be applied to other scientific fields. By this study, researchers may gain a better understanding of how these frameworks might evolve with different irregular aspects.

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Table 1 : Degree-based irregularity indices of a graph Θ.

S. No.	Irregularity Index	Expression
1.	Bell Index B(Θ) [17]	$\sum_{\hbar \in \Upsilon(\Theta)} \left(\lambda_\hbar - \frac{2\tau}{\eta} \right)^2$
2.	A(Θ) [18]	$\sum_{\hbar\xi \in \dagger(\Theta)} \left| \lambda_\hbar - \lambda_\xi \right|$
3.	IR1(Θ) [19]	$\sum_{\hbar \in \Upsilon(\Theta)} \lambda_\hbar^3 - \frac{2\tau}{\eta} \sum_{\hbar \in \Upsilon(\Theta)} \lambda_\hbar^2$
4.	IR2(Θ) [19]	$\sqrt{\dfrac{\sum_{\hbar\xi \in \dagger(\Theta)} \left(\lambda_\hbar \lambda_\xi \right)}{\tau}} - \dfrac{2\tau}{\eta}$
5.	IRF(Θ) [19]	$\sum_{\hbar\xi \in \dagger(\Theta)} \left(\lambda_\hbar - \lambda_\xi \right)^2$
6.	IRFW(Θ) [20]	$\dfrac{IRF(\Theta)}{\sum_{\hbar\xi \in \dagger(\Theta)} \left(\lambda_\hbar \lambda_\xi \right)}$
7.	IRA(Θ) [20]	$\sum_{\hbar\xi \in \dagger(\Theta)} \left(\lambda_\hbar^{\frac{-1}{2}} - \lambda_\xi^{\frac{-1}{2}} \right)^2$
8.	IRB(Θ) [20]	$\sum_{\hbar\xi \in \dagger(\Theta)} \left(\lambda_\hbar^{\frac{1}{2}} - \lambda_\xi^{\frac{1}{2}} \right)^2$
9.	IRDIF(Θ) [20]	$\sum_{\hbar\xi \in \dagger(\Theta)} \left| \dfrac{\lambda_\hbar}{\lambda_\xi} - \dfrac{\lambda_\xi}{\lambda_\hbar} \right|$
10.	IRLF(Θ) [20]	$\sum_{\hbar\xi \in \dagger(\Theta)} \dfrac{\left| \lambda_\hbar - \lambda_\xi \right|}{\sqrt{\lambda_\hbar \lambda_\xi}}$
11.	IRLA(Θ) [20]	$2 \sum_{\hbar\xi \in \dagger(\Theta)} \dfrac{\left| \lambda_\hbar - \lambda_\xi \right|}{\lambda_\hbar + \lambda_\xi}$
12.	IRDI(Θ) [20]	$\sum_{\hbar\xi \in \dagger(\Theta)} ln \left(1 + \left| \lambda_\hbar - \lambda_\xi \right| \right)$

13.	IRGA(Θ) [20]	$\displaystyle\sum_{\hbar\xi\in\dagger(\Theta)}\ln\left(\frac{\left|\lambdaslash_{\hbar}+\lambdaslash_{\xi}\right|}{2\sqrt{\lambdaslash_{\hbar}\,\lambdaslash_{\xi}}}\right)$

Table 2 : Link partition of $\Theta_1\left(\varsigma,\alpha\right)$ based on the degree of end nodes of each link.

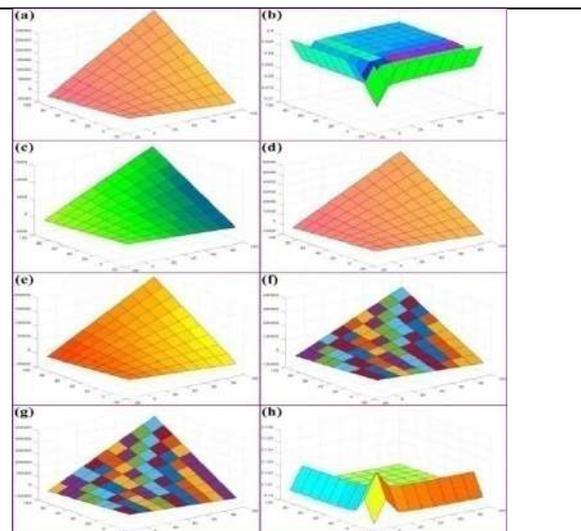| $\left(\lambdaslash_{\hbar},\lambdaslash_{\xi}\right)$ where $\hbar\xi\in\dagger\left(\Theta_1\left(\varsigma,\alpha\right)\right)$	Number of links
(1,3)	$6\varsigma\alpha$
(2,2)	$3\varsigma+3\alpha$
(2,3)	$8\varsigma\alpha-2\varsigma-2\alpha$
(3,3)	$15\varsigma\alpha-2\varsigma-2\alpha$
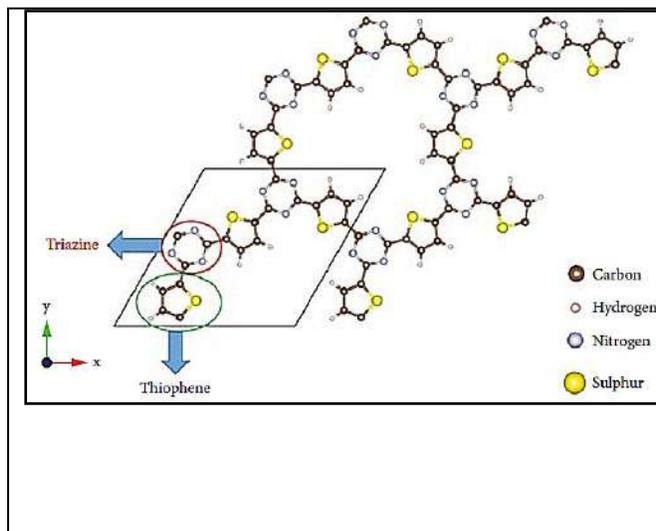
Fig. 1 The geometric structure of Θ₁(2, 2). The box indicates a unit cell.

Fig. 2 3-D surface plot of (a) A(Θ1) (b) B(Θ1) (c) IRA(Θ1) (d) IRB(Θ1) (e) IRDI(Θ1) (f) IRDIF(Θ1) (g) IRF(Θ1) and (h) IRFW(Θ1).
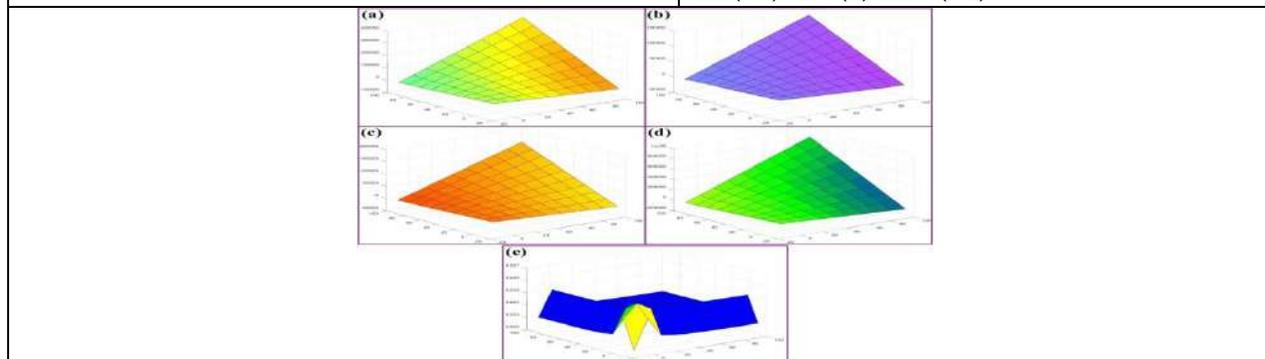
Fig. 3 3-D surface plot of (a) IRGA(Θ₁) (b) IRLA(Θ₁) (c) IRLF(Θ₁) (d) IR1(Θ₁) and (e) IR2(Θ₁).

RESEARCH ARTICLE

Preparation, Characterization and Antibacterial Activity of Zirconium Nano Particles using *Kalanchoe pinnata* Leaf Extract

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ABSTRACT

Kalanchoepinnata leaf extract was used in the Co-Precipetation method to synthesize zirconium dioxide nano particles. The prepared nano particle have been characterized by powder X-ray diffraction, Fourier transform infrared spectroscopy, ultraviolet spectra, also evaluated for their antibacterial efficiency against bacterial strains. The prepared ZrO_2 nano particles monoclinic structure, with an average crystalline size of about 20 nm, was shown by the XRD pattern. The growth of gramme positive Staphylococcus aureus and gramme negative E. coli bacteria was significantly inhibited by nano crystalline zirconium dioxide, as per the results of the antibacterial efficiency.

Keywords: *Kalanchoe pinnata*, Nano particles, Antimicrobial activity, Fourier transform infrared spectroscopy, X-ray Diffraction.

INTRODUCTION

Because of its great inflexibility and resistance to fracture, zirconium oxide (ZrO_2) is widely utilized in the fight against bacterial plaque. To solve this problem, ZrO_2 nano particles, a reliable antibacterial agent that can inhibit a variety of microbes, can be employed. The use of zirconia ceramics as implant biomaterials is growing in popularity [1]. Zirconia has been used in structural properties [2, 3], dental crowns [4,5], femoral heads for total hip replacement [6, 7], electrolyte for solid oxide fuel cells [8, 9], and catalytic applications [10, 11] due to its extraordinary mechanical, optical, electrical conductivity, and thermal properties. Materials with nanostructures showed diversephysio-chemical characteristics that are ignored in bulk materials. Compared to regular ZrO_2, nanosized ZrO2 has far superior chemical and physical properties. In terms of stability and safety, inorganic antimicrobial compounds have a substantial advantage over organic antimicrobial agents. The usefulness of nano particles in biological applications including nanomedicineis becoming more widely acknowledged [7]. The medical field benefits greatly from the use of nano particles in cancer therapy, drug delivery, and cell imaging. Although zirconia nano particles have potential medicinal uses, few research have looked at their involvement in dental imaging and bone tissue. This is an amazing example of nano science in medicine. This material is also useful in anti-infection applications. A major concern for public health is the on going rise in micro organisms resistance to antibiotics. Thus, the current investigation has attempted to highlight the antibacterialZrO_2 nano particle characteristics were ascertained by use of the agar diffusion method. Numerous synthesis approaches, such as co-precipitation [8], solid state reaction [9], hydrothermal method [10], sol-gel [11], and microwave aided solution method [12], have been used to produce nanosized zirconium dioxide particles. The microwave assisted solution technique for nano materials has gained popularity in recent years due to its several uses, including uniform heating, quick processing times, low power requirements, and unique synthetic properties [13]. This paper investigates the antibacterial activity, FTIR, UV, and XRD of prepared ZrO_2 nano particles.

EXPERIMENTAL

Preparation of Plant Extract

I bought fresh Kalanchoepinnata leaves from a nearby vendor. In a 500 ml beaker filled with 450 ml of double-distilled water, about 50g of leaves were boiled for 30 minutes. What mann No. 1 filter paper was then used to filter the extract. The filtrate was stored for the entire night at 4°C in a refrigerator.

Green Synthesis of Zirconia Nanoparticles

The process of green synthesis was used to preparation of zirconia nanoparticles. A 500 ml beaker containing 450 ml of plant extract. 50 ml of a 0.02M aqueous solution of zirconyl chloride octahydrate were added dropwise, agitated, and left at 80°C for two hours without any disturbances. A few days ago, the particles were formed. The resultant solution was allowed to evaporate for four hours at 150°C in a vacuum air oven. To convert hydroxide into ZrO_2, the materials were heated in a muffle furnace for three hours at 500°C.

Detection method

Using an X-ray diffracto meter (X-PERT PRO PANlytical, Netherlands), the XRD patterns of the materials were examined in order to determine their crystalline nature. As a diffraction source, CuKα radiation with a wavelength of λ = 1.5406 Å and a step size of 0.050 was employed, covering the diffraction range of 10-80º. A Shimadzu 8400S FTIR spectrometer was used to record the FTIR spectra, which were obtained in the 4000-400 cm-1 range. Using an agate mortar, the materials are finely divided in KBr before being compressed at 250 MPa into a circular disc with a diameter of 10 mm and a thickness of 0.5 mm. An infrared light source is used to dry these pellets. The produced nanoparticles' optical characteristics were noted using a JASCO UV visible spectrometer. ZrO_2 nano particles were assessed using the well-disc-diffusion method, which was applied tovalidate the antibacterial efficaciousness. The test organisms employed were clinical isolates viz., E. Coli, and Staphylococcus aureus which were procured from

Department of Microbiology, Coimbatore medical college and hospital (CMHC), Coimbatore. Nutrient agar medium was used to maintain the bacterial cultures. Finally, various zirconium oxide nanoparticle concentrations were added to each disk. For twenty-four hours, the antibacterial assay plates were incubated at 37°C. The sizes of the inhibitory zones were measured in mm.

RESULT AND DISCUSSION

UV-Visible Analysis

The UV-VIS absorption spectra of synthesized Zirconia nano particles dissolved in ethanol at room temperature is shows in the figure 1. A sharp peak observed at about 224 nm could be attributed to the band gap energy of This peak showed a small blue shift compared to the bulk. In the semiconductor nano particles, it is usually observed that band gap energy is increased (blue shift) with decreasing particle size .Apart from the strong absorption peak, a weak peak centered at 283 nm was observed. Which was followed by a peak at 403 nm with a shoulder of about 411 nm. In general, the emissions that appear at short wavelength can be ascribed to the excitation from the near band-edge transitions. The broad band and the substantial red shift of the band maximum, as compared to the band gap of the bulk material. The estimated optical band gap of the sample is lower than those of bulk zirconia.

FT-IR Spectrum

The FT-IR spectrum of the zirconia nano particle samples in the range 400–4000 cm−1 was observed in below figure in order to ascertain its molecular nature. The FT-IR spectrum of the ZrO2 nano particles in Figure shows a strong absorption with a maximum peak at 587 cm−1 , due to the Zr–O vibration, which confirms the formation of the ZrO_2 structure . The absorption peak in the region of 1388 cm−1 corresponds with O–H bonding, while a peak in the region of 1553 cm−1 may be due to the adsorbed moisture. A peak in the region of 3564 cm−1 is attributed to the stretching of O–H groups, characteristic of a highly hydrated compound. This highly hydrated compound enhances water uptake within the modified membranes with zirconia, which gives potential applications in fuel cells. The peak observed at 2300 cm−1 and 2322cm−1 corresponds with the structural O–H stretching of the nano materials. The peak observed in the region of 1550 cm−1 is due to the adsorbed moisture. Symmetric frequencies of Zr–OH were observed at 1080 cm−1.

XRD analysis

The product's cube phase was revealed by the XRD pattern. The expanding XRD peak revealed that the crystallite size of ZrO_2 was fine. The Scherrer formula was used to calculate the ZrO_2 sample's average crystalline size, which came out to be roughly 20 nm. Furthermore, a modest shift to higher or smaller d-values was seen in comparison to the reference pattern. which are properties of zirconium in a tetragonal phase and can be indexed to the standard pattern of the tetragonal phase of ZrO_2, which is in good agreement with reported data (JCPDS No.81-1544) (Chuah et al., 2001).. The peaks and bumps in these XRD patterns indicate that these materials are amorphous. These findings suggest that the samples' gradual aging favored thetetragonal structure growth, the monoclinic peaks completely disappeared.

Biological Activity

Test microorganisms

The test organisms used were clinical isolates *viz.,* ., *E. Coli*, and Staphy lococcus aureus which were obtained from Department of Microbiology, Coimbatore medical college and hospital (CMHC), Coimbatore. The bacterial cultures were maintained on nutrient agar medium.

Growth and Maintenance of Test Microorganism for Antimicrobial Studies

The bacterial cultures was maintained on nutrient broth (NB) at37°C.

Preparation of Inoculums

The gram positive bacteria, Staphylococcus aureus, and gram negative bacteriaE.Coliwere pre-cultured in nutrient broth overnight in a rotary shaker at 37°C, centrifuged at 10,000 rpm for 5 min, pellet was suspended in double distilled water and the cell density was standardized spectro photo metrically (A_{610} nm). The samples were tested by the well diffusion method. Different concentration of the extracts (100 μg/ml) was prepared by reconstituting with methanol. The test microorganisms were seeded into respective medium by spread plate method 10 μl(10 cells/ml) with the 24h cultures of bacteria growth in nutrient broth. After solidification the filter paper wells (5 mm in diameter) impregnated with the extracts were placed on test organism-seeded plates. Amoxicillin (10 μg) used as standard for antibacterial test. The antibacterial assay plates were incubated at 37°C for 24hrs. The diameters of the inhibition zones were measured

in mm.

CONCLUSION

The present study the eco-friendly and convenient greener route synthesis of ZrO_2 nano particles using *Kalanchoe pinnata* leave sextract. FTIR and XRD pattern of the samples proved the formation of ZrO_2 nano particles and their crystalline structure. Synthesized ZrO_2 nano particles exhibited significant bacterial activity against Escherichia coli, Streptococcus aureus.

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Table 1 XRD Data of Zirconiananoparticles

Pos. [°2Th.]	Height [cts]	FWHM Left [°2Th.]	d-spacing [Å]	Rel. Int. [%]
30.0565	30.26	1.5744	2.97320	100.00
49.3483	1.71	3.9360	1.84674	5.64

Table 2. Composition of Nutrient agar medium

Peptone	5.0 g
Beef extract	3.0 g
Agar	15.0 g
Distilled water	1000 ml
Ph	7.0

Table-3 Anti-bacterial Activity of ZrO$_2$Nanoparticles

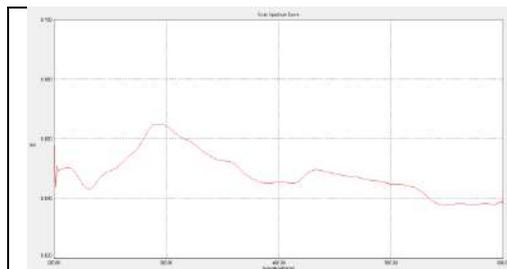| S.No	Pathogenic bacteria	Zone of inhibition (mm)			Standard (Amoxicillin)
		10 ug	20 ug	30 ug	
1.	*E.Coli*	05	09	16	22
2.	*Staphylococcus aureus*	05	09	15	24

Fig. 1 UV-Vis spectrum of Zirconia nanoparticles	**Fig 2 FT-IR spectrum of Zirconiananoparticles**
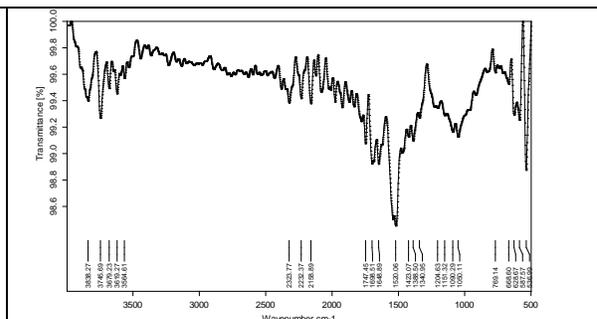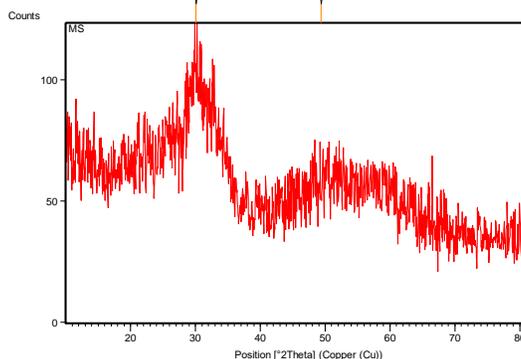
Fig 3 XRD spectrum of Zirconiananoparticles
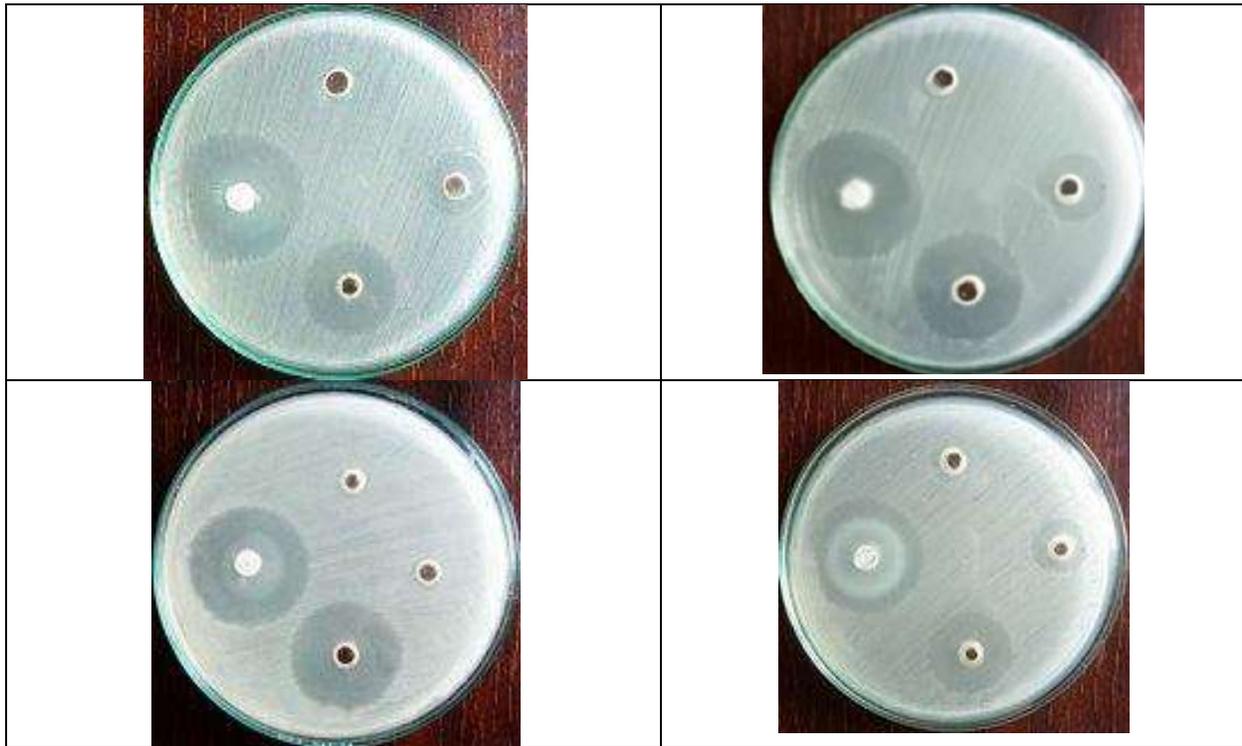
Fig 7 (A-B). Antibacterial activity of Zirconia nanoparticles of (A)*Escherichia coli* **(B)** *Staphylooccus aureus*

RESEARCH ARTICLE

Phytochemical Screening of Medicinal Plant *Justicia gendarussa* Burm.f. for Its Antibacterial and Antioxidant Activity

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ABSTRACT

Justici agendarussa Burm.F. was a herbal plant that contains chemical compounds such as alkaloids, saponins, flavonoids, polyphenols, essential oils, tannins and steroids. The plant extraction has been carried out by these following three chemical compounds such as Chloroform, Distilled Water, Methanol and Acetone. *Justici agendarussa Burm.F.* has long been used as an anti-inflammatory and pharmacologically,this plant has been reported that have antibacterial, analgesic, anthelmintic, anti-cancer, anti-inflammatory, antioxidant, anti-HIV, toxicity, sedative hypnotic and male contraception drugs. Phytochemical analysis of the leaf extract of *Justici agendarussa* on four different solvents shows that Alkaloids are present in all solvents except chloroform. Carbohydrates are present in Acetone and Distilled water but absent in methanol and chloroform solvents. Flavonoids are present in all solvents except in chloroform. Glycosides and Saponoins are present in all solvents. Tannins absent in all solvents except acetone. Protein are present in Acetone and Distilled water but absent in methanol and chloroform solvents. Antibacterial activity reported against pathogens such as *Escherichia coli, Stretomyces aureus. Pseudomonas* showed that the plant extract can be used to treat diseases caused by these bacteria. Antioxidant activity was determined at ambient temperature by means of a 2,2 - diphenyl-1-1-picrylhydryzyl (DDPH) colorimeter.

Keywords: *Justici agendarussa*, Antioxidant, Antibacterial, Phyto chemical, Medicinal plant.

INTRODUCTION

Herbal medicines derived from plant extracts are being increasingly utilized to treat a variety of clinical diseases, though relatively little knowledge about their mode of action is available. *Justici agendarussa* belongs to family Acanthaceae is commonly known as Nili-Nirgundi. The plant is up to one meter height and found in tropical and subtropical parts of Asia and in India at seashore area like Valsad, Surat and Hills likePavagarh. J. gendarussa herb is cultivated in Indian gardens for its attractive foliage and flowers. The herb is cultivated in Indian gardens for its attractive foliage and flowers (Abeloff,2008;Altschuler*et al*,2007; Birks *et al*,2007).To explore the possibility of using the traditional medicine with proper chemical and pharmacological profiles, there has been a large volume of work aimed at scientific validation of efficacy of herbal drugs used in the traditional medicine(Fabricant *et al*,2001).*Justicia* belongs to the family Acanthaceae, which are scattered in Asia, such as China, Philippines, India, Indonesia, Malaysia, Sri Lanka, Pakistan, Thailand and the Andaman Islands. *J.gendarussa* grew wild in the forest and can also be planted as a medicinal plant or hedge plant (Sinansari*et al*,2018). Traditionally the plant has vigorous therapeutic application and is used in the treatment of human immunodeficiency viruses (HIV), inflammation, bronchitis, vaginal discharges, eye diseases, dyspepsia and male contraception with constituents like alkaloids, flavonoids, terpenoids, carotenoids, phenolic compounds, sugar, starch etc.(Mangai,2018).

In Malaysia, the leaves are applied for politicking to treat head ace and pains, as a lotion to treat swelling and rheumatisum and in bath after confinement, the roots treat for thrush and cough (Wahi*et al*, 1974).The sequential screening for phytochemicals of *j.gendarussa* leaves are rich in alkaloids, flavanoids, saponin, carbohydrates, steroids, triterpenoids, carotenoids, aminoacids, tannins, phenolics, coumarines and Anthraquinones. Major active components of their species are the flavonoids vitexin, apigenin and also sitosterols, alkaloids and reducing sugars(Woodham and Peters,1998).Leaves contain a bitter alkaloid (justiciine) and they are rich in potassium salts. Root is bitter in taste considered anodyne, antiperiodic, antiplasmodic, carminative, diaphoretic, diuretic, emetic, febrifuge and laxative (Marathakam*et al*,2012).*J.gendarussa*has pharmacological effects such as fever, cough, jaundice, mouth sores, arthritis, cephalgia, hyplegia, facial paralysis, bronchitis, chronic rheumatism, liver disorders, respiratory disorders, indigestion, anti-inflammatory, and anti-cancer(Altschuler*et al, 2017*). The phyto chemical analysis of the plants is very important commercially and has great interest in pharmaceutical companies for the production of the new drugs for curing of various diseases. The phyto chemical research approach is considered effective in discovering bioactive profile of plants of therapeutic importance(Ojinnaka*et al*,1984).

MATERIALS AND METHODS

Collection and drying of plant materials
Justici agendarussa Burm was collected from Annamalai nagar, Department of Botany, Annamalai University, Chidambaram. Plants were appropriately rinsed with distilled water to purge dust, dirt and other possible parasites and then were shade dried at 25-30ºC. The dried parts root, stem, and leaves were pulverized incoherently and then stored in clean, dried plastic bags for extraction.

Extraction of plant materials
For the preliminary phyto chemical analysis, extract was prepared by weighing 50 gm of the dried powdered stem, leaf and root was subjected to hot successive continuous extraction with 250 ml n-distilled water, chloroform, acetone and ethanol solvents. The extraction process was carried out for 72 hrs and then the extract was collected. It was evaporated in a hot plate and residue was collected, kept in desiccators. All the extracts obtained by successive extraction method are subjected to qualitative phytochemical analysis.

Preliminary Phytochemical Analysis(Subramanian*et al*,2012)
A systematic and complete study of crude drugs should include a complete investigation of both primary and secondary metabolites derived from plant metabolism. The different qualitative chemical tests are to be performed establishing profiles of the given extracts for their nature of chemical composition. Following chemical tests were carried out for different extracts of *Justiciagentrarussa*to
identify the presence of various phyto chemical constituents.

Test for Carbohydrates(Kokate *et al*,2001)
To 2ml of plant extract, 1ml of Molisch's reagent was added. Presence of purple (or) reddish colour indicates presence of Carbohydrates.

Test for Tannins
To 1ml of plant extract, 2ml of 5% ferric chloride was added. Formation of dark blue or greenish black colour indicates the presence of tannins.

Test for Saponins
To 2ml of filtrate, 2ml of Distilled water was added and shaken in a graduated cylinder for 15mins lengthwise 1cm, layer of form foam indicates the presence of Sapon in.

Test for Flavanoids(Mills et al,2000)
To 2ml of filtrate, 1ml of 2N NaOH was added presence of yellow colour indicates the presence of flavonoids.

Test for Alkaloids(Cromwell,1955)
Dragendorff's Test (Potassium Bismuth Iodide): The acid layer was treated with few drops of Dragendorff's reagent Formation of reddish brown precipitate indicates the presence of alkaloids.

Hager's Test
The acid layer was treated with few drops of Hager's reagent. Formation of yellow precipitate indicates the presence of alkaloids.

Test for glycosides(Subramanian*et al*,2012)
Borntragers Test
2ml of chloroform solutions of the extracts of Justiciagentrarussa. were treated with 1ml of dilute (10%) ammonia and shaken. Pink-red color in the ammoniacal (lower) layer indicates the presence of anthracene derivatives.

Cardiac Glycosides
2ml of chloroform solutions of the extracts of *Justiciagentrarussa.* were treated with conc.H_2SO_4. Appearance of ring at the inter phase indicates the presence of deoxysugars in cardenolides.

Test for Protein
To 2ml of filtrate, 1ml of 0.2% Ninhydrin reagent was added and heated blue colour reveals the presence of proteins.

Antibacterial activity
Different zone of inhibitions were shown by extracts and fractions of leaves of *Justici agendaruss a* with different concentrations. The extracts / fractions obtained from our selected plants were screened against different bacterial strains. Peptone was taken as control for antibacterial activity. Bacterial culture was inoculated in the test tubes. To check the turbidity the following microorganisms were treated with the extract *Staphylococcus aureus, Klebsiella pneumonia, Pseudomonas aeruginosa.* The extracts of Sample shown no effects against the tested bacteria and there was no Zone formation in any of the extracts. Graph represents the zone of formation (mm) of Sample (Fig2) for all the tested organisms and shows maximum activity against bacilli for the acetone and ethyl acetate extracts.

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Antioxidant/free radical scavenging activity

The extract was filtered and dried. The extract was dissolved in methanol with a final concentration of 1mg/ml. The free radical scavenging activity of the extract was analyzed by the DPPH. The extracts were dissolved in 1ml of methanol and mixed with 1ml of DPPH solution. The mix was vortex and in cubated for 30mins. The O.D of the solution was then measured at 518nm in UV spectrometer.

$$\text{Radical scavenging activity} = \frac{\text{Absorbance of Control} - \text{Absorbance of Sample}}{\text{Absorbance of control}} \times 100$$

RESULT AND DICUSSION

Phytochemical analysis of the leaf extract of *Justici agendarussa* on four different solvents shows that Alkaloids are present in all solvents except chloroform. Carbohydrates are present in Acetone and Distilled water but absent in methanol and chloroform solvents. Flavonoids are present in all solvents except in chloroform. Glycosides and Saponoin are present in all solvents. Tannins absent in all solvents except acetone. Protein are present in Acetone and Distilled water but absent in methanol and chloroform solvents. The results of phytochemical analysis of *Justici agendarussa* leaves extracts from different solvents were tabulated (Table1). The acetone extract of crude sample showed 62.5% inhibition of DPPH radicals and chloroform extract showed 45.5% inhibition of DPPH radicals. The acetone extract of leaf shows increase percentage of free radical scavenging activity. On comparing antioxidant activity (Table 2) of the three different samples of *Justici agendarussa* the Acetone extract showed the maximum percentage inhibition of DPPH radicals among the other different solvents. Phytochemicals in plant material have raised interest among scientists, food manufacturing and pharmaceutical industry, as well as consumers for their roles in the maintenance of human health. Phytochemicals are the bioactive, non-nutrient, and naturally occurring plant compounds found in fruits, vegetables, and whole grains. They can be categorized into various groups, i.e., polyphenols, organosulfur compounds, carotenoids, alkaloids, and nitrogen-containing compounds.

Many phyto chemicals are potent effectors of biologic processes and have the capacity to influence disease risk via several complementary and overlapping mechanisms. In recent times there has been considerable significance in the use of plant material as an unconventional method to control pathogenic microorganism(Pushparani*et al*,2017) and many components of plants products have been shown to be particularly targeted against resistant pathogenic bacteria (Aqil*et al*,2005). The appearance of multidrug resistant strain of many pathogens is a severe threat and makes chemotherapy more difficult. Furthermore, the current price of most of the chemotherapeutic agents is intolerable to the public particularly in developing countries like India (Nostro*et al*,2006). Therefore attempts must be directed towards the development of effective natural, non-toxic drug for treatment (Gopalkrishnan Sarala*et al* ,2010). Therefore the present work was carried out to explore the antimicrobial property of *Justici agendarussa.* The plant based products have been effectively proven for their utilization as source for antimicrobial compounds. AC – Acetone; MTH-Methanol; CHF- Chloroform; AQ-Aqueous.'+' indicates the presence of the particular phytochemical, '–' indicates the absence of the particular phytochemical

CONCLUSION

The present study demonstrates the phyto chemical assessment of *Justici agendarussa.* These phyto chemicals seems to be responsible for diverse biological assays of the plant extracts. The current study report antimicrobial activities of *J. gendarussa* for the first time. Our results showed that both the plant species shows good potential against the tested antimicrobial essays. Based on our results it is recommended that the crude extracts and different solvent soluble fractions of our selected plants can be used for therapeutic purposes and also would escort to synthesize safe herbal drugs with least side effects.

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Table 1.**Results of phytochemical analysis of** *Justiciagendarussa*

Phytochemicals	AC	MTH	CHF	AQ
Alkaloids	+	+	-	+
Carbohydrates	+	-	-	+
Flavonoids	+	+	-	+
Glycosides	+	+	+	+
Saponoins	+	+	+	+
Tannins	+	-	-	-
protein	+	-	-	+

Table 2. Antioxidant activity of *Justici agendarussa* **O.D Taken At 517nm**

Solvent	Inhibition %
Aqueous	8.018
Methanol	30.25
Acetone	62.5
Chloroform	45.52

Fig1.a)Phytochemical test of *Justiciagendarussa*	**Fig1.b)Phytochemical test of** *Justiciagendarussa*
Fig1.c)Phytochemical test of *Justiciagendarussa*	**Fig1.d)Phytochemical test of** *Justiciagendarussa*
Fig1.e)Phytochemical test of *Justiciagendarussa*	**Fig1.f)Phytochemical test of** *Justiciagendarussa*

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Fig2.Antibacterial activity of *Justici agendarussa in leaves*

RESEARCH ARTICLE

GC-MS Analysis of Synergistic Bioactive Component of Antifungal Ointment (Luliconazole) and Clove Essential Oil (*Syzygium aromaticum*) against Pathogenic Fungi (Dermatophytes)

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ABSTRACT

Worldwide, an increase in the prevalence of fungal infections, particularly dermatophytosis, has been noted. The members of the research community to look for alternative natural substances such as essential oils have been spurred by the resistance of some species of fungi to antifungal medicines, expensive treatment costs, and toxic effects of present drugs. In the current investigation, the antifungal activity of clove oil was assessed in vitro using the agar disc diffusion method at various dilutions (0, 10, 20, 50, and 100%) on the isolated fungus (*Trichophyton sp, Microsporum sp. Epidermophyton sp*). The combination effect of antifungal ointment and essential oil with natural products from plants is a prospective strategy to produce a new potent antifungal agent. As a result, this research demonstrated that antifungal ointment mixed with essential oil shows a synergistic effect. GC-MS was used to identify phytochemicals and bioactive substances in combination of clove oil and antifungal ointment (Luliconazole). The bioactive components available in mixture were compared to recognized substances in the National Institute of Standards and Technology's database library (U.S.). Agar well diffusion was used to test the antifungal efficacy and synergistic effects of AFOs with clove oil.

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GC-MS *divulged* one hundred sixty-one (161) bioactive compounds in Clove oil and AFOs, respectively. Minimum Inhibitory Concentration (MIC) by Clove oil AFOs ranged from 1.25 to 10.0 mg/ml. Combinatory effects of AFOs with Clove oil revealed synergistic properties. A promising alternative therapy to treat dermatological infections without side effects is the development of innovative products employing bioactive compounds from plants and commercially available AFCs.

Keywords: AFOs, Dermatophytes, AFCs, MIC, GCMS.

INTRODUCTION

Mycotic illnesses are increasingly considered a substantial public health problem because they cause high morbidity (1,2). By overusing broad-spectrum antibiotics, which reduce the number of non-pathogenic bacteria that inhibit the growth of fungus through competition, the spread of fungal illnesses is growing(3). Antifungal medications are effective in treating some fungal infections, but their abuse always makes the problem worse. Superficial and subcutaneous fungal infections can be highly hazardous if not treated quickly, effectively, and with the necessary medications. Over the years, resistance has been encountered frequently due to the improper use of antifungal medications(4,5).Deep and superficial fungal infections are both treated with anti-fungal chemotherapy. The ideal way to combat the main skin dermatophytes may be by topical application of anti-fungal medications, which guarantees direct access and a better retention rate at the target. Topical administration also helps to prevent pre-systemic metabolism and lessen systemic toxicity. Different medications, such as clotrimazole, itraconazole, and ketoconazole, are applied topically to the skin by rubbing or spreading(6). The topical administration of anti-fungal medications, however, has been linked to undesirable skin responses, including allergic rashes and itching. Additionally, standard formulations require frequent administration at high doses, which increases the risk of both local and systemic toxicity(7).Aside from various adverse effects caused by commercially available antifungal medications, worldwide drug resistance to numerous treatments is rapidly increasing, and the effectiveness of a single antibiotic against resistant microbes is declining. Pathogenic dermatophytic multi-drug resistance is forcing ongoing therapeutic failure, which urgently calls for an innovative complementary strategy to the development of new, effective antimicrobial medicines. A blueprint for the development of efficient antifungal drugs or creams from natural herbs is now a point of consensus among researchers, medical professionals, and pharmaceutical companies(8).

This will help overcome the limitations of conventional therapy and produce antifungal agents with dose efficiency. Combining the effects of commercial antifungal medications with natural items will show great effectiveness in treating fungal infections while improving the efficacies of antibiotics (creams, ointments or pills) and reducing their adverse effects. It will be a complementary and alternative strategy to fight recurrence occurrences of fungal infection to combine and synergistically affect commercial antifungal medications with natural bioactive substances from plants(5). Medicinal plants are loudly sources of treasurable secondary metabolites and thus, subsidize to accessibility of natural drugs in globally(5). One of the most significant plants in conventional medicine, clove (*Syzygium aromaticum*) is a member of the Myrtaceae family(9). Clove essential oil is used in aromatherapy and in dentistry emergencies to relieve toothaches. The chemical groups and classes that make up clove oil include monoterpenes, sesquiterpenes, and phenolic hydrocarbons(10).Eugenol, a volatile phenylpropanoid that is widely employed in the pharmaceutical business, is the principal component of flower bud essential oil and is considered to be its primary chemotype.

Additionally, it includes humulene, -caryophyllene, and eugenol acetate. *S. aromaticum* has shown antiviral activity against viruses that are spread by food, antibacterial activity, with low quantities being able to stop bacterial development, and efficacy in the treatment of bacterial illnesses(11,12).Their compounds have biological advantages such as antioxidant, insecticidal, antifungicidal, anticarcinogenic, antibacterial and anesthetic properties.

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Additionally, due to its abundance in several phytochemicals such sesquiterpenes, monoterpenes, hydrocarbons, and phenolic compounds, it has antiprotozoal properties(13,14,15). Clove oil has a variety of uses in the pharmaceutical and cosmetic industries, as evidenced by its therapeutic potential in phytomedicine. Therefore, biologically active compounds in medicinal plants can be exploited and incorporated in AFCs, which will be a newsworthy option towards new prototype antifungal agents. Natural products in plants act as reservoirs of novel bioactive compounds and as excellent source of drug discovery with diverse biopharmaceutical applications(16,5). This study therefore, revealed synergistic antifungal potential of over-the-counter AFOs with Clove oil against clinically important Dermatophytes.

MATERIALS AND METHODS

Collection and identification of plant materials
In this study plant oils (Clove oil, Eucalyptus oil and Ginger oil) were procured from local ayurvedic medical shop of Dehradun, Uttarakhand, India.

Source of antifungal ointments (AFOs)
The commercially available AFOs namely; Clotrimazole (1%), Miconazole Nitrate (2%), Ketoconazole (2%), Fusidic Acid (0.2%), Clobetasol (0.05%), Luliconazole (1%) and Terbinafine Hydrochloride (1%) were used. These AFCs were certified by National Agency for Food and Drug Administration and Control (NAFDAC), a federal agency under the Federal Ministry of Health.

Collection of Dermatophytes
The tested dermatophyte isolates viz: *Trichophyton sp.*, *Microsporum sp.* and *Epidermophyton sp.* were isolated from mild and chronic dermatophytosis cases from OPDs of different clinics of Dehradun District. MTCC strains viz., *Trichophyton rubrum* (MTCC 296), *Microsporum gypseum* (MTCC 2819), and *Epidermophyton flaccosum* (MTCC 7880) were also procured from IMTECH, Chandigarh, India as a control agent.

Determination of Phytochemicals and Bioactive Compounds in Clove Oil and AFOs
The bioactive compounds in the Clove oil and AFOs were identified with the aid of gas chromatography– mass spectrometry (QP2010 plus Shimadzu, Japan), Column, GC, SH-I-5Ii MS Capillary, 30m x 0.25mm x 0.25um, injection mode: Split less. The operating conditions of the GC-MS set for the analysis were as follow: oven temperature 45°C for 2 min then 140°C at 5°C/ min and finally increased to 280°C ad held isothermally for 10 min. The sample injection was 2μL and the carrier gas was helium at 1mL/min. The ionization of the sample components was carried out 70Ev. NIST14.L library (2020) was then searched to compare the structures of the compounds with that of the NIST database. Compounds were then identified based on the retention times and mass spectra with already known compounds in the NIST library (C:\Database\NIST14.L).

Antifungal activities of Clove oil and AFOs
The antifungal assay was carried out using the agar well diffusion method described by CLSI[7]. A suspension of dermatophytic strain (1.0 × 105 sfu/ml) was adjusted with the aid of spectrophotometer (UNICO S-1100 RS) to 0.5 McFarland standard. Dimethyl sulfoxide (DMSO 2% v/v) was used to reconstitute since most of AFOs and plant extracts (Clove oil) were not soluble in sterile distilled water. The concentration of AFOs, and Clove oil were reconstituted to 10.0 mg/ml. Plant extract was sterilized using a Millipore membrane filter (0.22 μm). The sterility of AFOs and Clove oil were confirmed after Millipore filtration, by introducing 0.1 ml of supposed sterile extract into sterilized Sabouraud's dextrose agar. Each labelled plate was seeded with tested dermatophyte by means of sterile swab stick rolled on Sabouraud's dextrose agar and Nutrient agar media. Sterile cork borer was used to make well (6 mm) in the Petri dishes. Aliquots of Clove oil (1000 μl) and AFOs (10 mg) were dropped in each well. The plates were incubated at 26 °C for 48 h. The zones of inhibition around well were measured in millimetres (mm). For synergism activity, concentration of each AFOs and Clove oil was adjusted to 3.0 mg/ml.

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Determination of Minimum Inhibitory and Fractional Inhibitory Concentration Index (FICi)

The minimum inhibitory concentration was determined by using method described by CLSI[7]. The varying concentrations of 1.25, 2.5, 5.0, and 10.0 mg/ml for AFOs and Clove oil were prepared and incorporated into a set of sterile tubes. Each test tube was inoculated with 0.1 ml of standardized fungal inoculum and incubated at 26 °C for 48 h. The MIC were recorded as the lowest concentration to prevent growth of macroscopically visible colonies on plates, while there was visible growth on plates without AFOs and Clove oil. To determine MIC of combined AFO with Clove oil, varying concentrations of 1.0–3.0 mg/ml was used. The synergism, indifference, and antagonism of combined AFO with Clove oil were screened on the studied dermatophytes.

RESULTS

Inhibitory Potentials and Synergistic Antifungal Efficacy of AFOs With Clove Oil Against Pathogenic Fungi-

The antifungal activity of the antifungal ointments and essential oils against dermatophytes (*Trichophyton sp.*, *Epidermophytone sp.*, *Microsporium sp.*) was measured in this study. AFOs specifically- Clotrimazole, Fusidic acid, Luliconazole, Ketoconazole, Clobestol, Terbinafine and Miconazole, and Essential oils specifically- Clove oil, Eucalyptus oil and Garlic oil against tested dermatophytes. Clove oil exhibited more prominent inhibitory effects than AFOs. Clotrimazole, Fusidic acid, Ketoconazole, Clobestol, Terbinafine and Miconazole were devoid of inhibitory effect against the dermatophytes as compared to Luliconazole. Luliconazole displayed zones of inhibition against tested dermatophytes with values ranged from 8 mm to 26 mm, Clove oil have inhibitory zones of 10 mm to 39 mm and mixture of Luliconazole & Clove oil have inhibitory zones of 11 mm to 40 mm respectively.

Evaluation of Antifungal Activity of the Antifungal Ointments, Essential Oils and Antifungal Drugs Against Dermatophytes

The data presented in table 1 showed- the maximum antifungal susceptibility observed by Ketoconazole ointment (61%), clove oil (83%), Eucalyptus oil (83%) and Ketoconazole drug (78%) against *Trichophyton sp.* The highest antifungal susceptibility observed by Luliconazole ointment (100%), Terbinafine ointment (100%), Ketoconazole ointment (60%), Clotrimazole ointment (60%), Miconazole ointment (60%), Clove oil (100%), Eucalyptus oil (60%) and Terbinafine drug (100%), Ketoconazole drug (80%) against *Epidermophytone sp.* The highest antifungal susceptibility observed by Luliconazole ointment (100%), Terbinafine ointment (100%), Ketoconazole ointment (60%), Clotrimazole ointment (60%), Miconazole ointment (60%), Clove oil (100%), Eucalyptus oil (100%) and Fluconazole drug (100%), Ketoconazole drug (100%), Itraconazole drug (100%) against *Microsporium sp.*

Combinatory Synergistic Effect of AFOs And Clove Oil Against Dermatophytes

All the dermatophytes isolated from skin were susceptible to one or more antifungal ointments, antifungal drugs and essential oil. In this study synergistic antifungal activity was evaluated for the remaining five combinations. A synergistic effect was observed because the inhibitory activity of the mixture was more than those of the individual. Combination of Antifungal ointments and Clove oil against *Trichophyton sp.*: When these two were mixed the growth inhibitory activity were: Luliconazole + Clove oil (95.12%), Ketoconazole + Clove oil (85.36%), Clotrimazole + Clove oil (60.97%), Miconazole + Clove oil (48.78%), Terbinafine + Clove oil (31.70%). Combination of Antifungal ointments and Clove oil against *Microsporium sp.*:When these two were mixed the growth inhibitory activity were: Luliconazole + Clove oil (100%), Ketoconazole + Clove oil (50%), Clotrimazole + Clove oil (0%), Terbinafine + Clove oil (50%), Miconazole + Clove oil (25%). Combination of Antifungal ointments and Clove oil against *Epidermophytone sp.*:When these two were mixed the growth inhibitory activity were: Luliconazole + Clove oil (100%), Terbinafine + Clove oil (60%), Miconazole + Clove oil (60%), Clotrimazole + Clove oil (40%), Ketoconazole + Clove oil (0%) (Table-2). Luliconazole + Clove oil displayed the highest (p < 0.05) zones of inhibition of 50 mm, 45 mm and 40 mm against Epidermophytone (MTCC-7880), microsporium sp. (MTCC-2819) Trichophyton sp. (MTCC-296). Luliconazole (AFO) + Clove oil against Trichophyton sp., Luliconazole (AFO) + Clove oil against Microsporium sp., Luliconazole (AFO) + Clove oil against Epidermophytone and Luliconazole (AFO) + Clove oil against (MTCC) displayed

synergistic properties. Other combinatory effects of Antifungal ointments with Clove oil, Anti-fungal drugs with Clove oil and Clove oil with Eucalyptus oil were showed antagonistic effect.

Phytochemical and Bioactive Compounds in AFOs (Luliconazole) and Clove Oil as revealed by GC-MS

The results of the preliminary screening shown in figure -1 clearly indicate that Chromatogram of Luliconazole and Clove oil with peaks for various bioactive constituents. The peaks were shown 162 bioactive compounds in AFOs and Clove oil, respectively. Table- 3, show the presence of bioactive compounds in Luliconazole and Clove oil, respectively identified with GC MS. Eugenol (59.69%) was the major compound and other bioactive compounds such as Zingiberene, Acetyleugenol, Spathulenol, Arachidonic acid, Anisylacetate, Phthalic acid, Acepromazine, Widdrol, Chamigrene, Benzoic acid, Propeoic acid, Caryophlene acid, Farnesol, Humulene epoxide I, Pogostole, Propanone, Ether, Ascabiol, Bisomel etc found in the Luliconazole and Clove oil (Table- 3)

DISCUSSION

Fungal skin infections are one of the most widely distributed types of cutaneous and mucocutaneous infections, which represent a serious public health issue(17). The ongoing development of various antibiotic resistance by pathogenic fungal strains has prompted research across the board, which has indicated the urgent need to investigate fresh possible strategies to advance antifungal therapeutics(18,5). In this study, the combinatory potential of AFOs with Essential oils was assessed. Luliconazole was efficient AFO against dermatophytes in vitro. The azole drug luliconazole has potent anti-fungicidal properties against Trichophyton species, much as terbinafine.

A combination of luliconazole's powerful in vitro antifungal activity and its advantageous pharmacokinetics in the skin may be the cause of its potent antifungal action(19). In this investigation, the in vitro antifungal efficacy of over-the-counter AFOs (Luliconazole) and their synergistic interactions with Essential oil (clove oil) against dermatophytes from clinical sources were attributed to phytochemicals as well as bioactive components in essential oils. Natural chemical substances found in plants called phytochemicals are biologically active and can fight against illnesses (5).These biologically active phytochemicals, which include phenol, flavonoids, saponins, alkaloids, steroids, terpenoids, cardiac glycosides, anthraquinones, and tannins, are present in the investigated extracts, making them beneficial for a variety of medical applications, including antimicrobial against pathogenic microorganisms. The one hundred sixty-two chemical elements were qualitatively found in the combination of luliconazole and clove oil: eugenol and caryophyllene are as major components. These components have antibacterial, anti- fungal, anti-inflammatory, insecticidal, and anti-oxidant potential, making them potentially useful for the preparation of both herbal and modern medicines(20). They are also traditionally used as a flavoring agent and antimicrobial material in the food industry. Additionally, it has medicinal uses in traditional medicine such as antiphlogistic, anti-vomiting, analgesic, anti-carcinogenic, antispasmodic, anti-carminative, renal support, antiseptic, diuretic, odontalgic, stomachic, tonicardic, and antispasmodic(17). Along with its carminative and simulative properties, it is renowned for its fragrant condiment value. Potential synergistic interactions between two or more AFOs and essential oils can reduce the occurrence of resistance mutants, increase their potency against pathogens, and operate as an efficient alternative to conventional medicine for the treatment of many fungal infections(5).

ACKNOWLEGEMENT

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Table-1: Antifungal activity of antifungal agents against Dermatophytes

Antifungal agents	Dermatophytes					
Ointments	Trichophyton sp.	Trichophyton sp. (MTCC-296).	Microsporum Sp.	Microsporum sp. (MTCC-2819)	Epidermophyton sp.	Epidermophyton sp. (MTCC-7880)
Fusidic Acid	1(2.4%)	R	0 (0%)	R	0 (0%)	R

Luliconazole	15(36.6%)	S	3 (75%)	S	5 (100%)	S	
Ketoconazole	25 (60.9%)	S	0 (0%)	R	3 (60%)	S	
Clobestol	0 (0%)	R	4 (100%)	S	0 (0%)	S	
Clotrimazole	19 (46.3%)	S	2 (50%)	S	3 (60%)	S	
Terbinafine	8 (19.5%)	S	4 (100%)	S	5 (100%)	S	
Miconazole	14 (34.1%)	S	4 (50%)	S	3 (60%)	S	
Drugs							
Fluconazole	30 (73.2%)	S	4 (100%)	S	3 (60%)	S	
Terbinafine	20 (48.7%)	S	1 (25%)	S	5 (100%)	S	
Ketoconazole	32 (78%)	S	4 (100%)	S	4 (80%)	S	
Griseofulvin	1 (2.4%)	R	0 (0%)	R	0 (0%)	S	
Itraconazole	16 (39%)	S	4 (100%)	S	1 (20%)	S	
Oils							
Clove oil	34 (82.9%)	S	4 (100%)	S	5 (100%)	S	
Eucalyptus oil	34 (82.9%)	S	4 (100%)	S	3 (60%)	S	
Garlic oil	8 (19.5%)	R	0 (0%)	R	0 (0%)	R	

*All test were performed in triplicate manner

Table-2: Antifungal activity of combined AFOs with Clove oil against Dermatophytes:

Antifungal agents	Dermatophytes					
Ointments + Clove oil	Trichophyton sp.	Trichophyton sp. (MTCC-296).	Microsporum Sp.	Microsporum sp. (MTCC-2819)	Epidermophyton sp.	Epidermophyton sp. (MTCC-7880)
Luliconazole + Clove oil	39 (95.12%) **S**	**S**	4 (100%) **S**	**S**	5 (100%) **S**	**S**
Ketoconazole+ Clove oil	35 (85.36%) **S**	**S**	2 (50%) **A**	**S**	0 (0%) **A**	**S**
Clotrimazole+ Clove oil	25 (60.97%) **A**	**S**	0 (0%) **A**	**S**	2 (40%) **A**	**S**
Terbinafine+ Clove oil	13 (31.70%) **A**	**S**	2 (50%) **A**	**S**	3 (60%) **A**	**S**
Miconazole+ Clove oil	20 (48.78%) **A**	**S**	1 (25%) **A**	**S**	3 (60%) **A**	**S**

S – Synergistic, A - Antagonistic

*All test were performed in triplicate manner

Table-3: Main component and the relative contents of AFOs and Clove oil as revealed by GCMS

Peaks	Retention time	Area %	Bioactive compounds	Molecular formula	Molecular weight	properties
6	23.890	59.69	Eugenol	$C_{10}H_{12}O_2$	164	Antibacterial, Analgesic and Antioxidant, Antineoplastic agent, an apoptosis inducer
7	24.555	6.62	Caryophyllene	$C_{15}H_{24}$	204	Non-steroidal anti-inflammatory drug, a fragrance, a metabolite and an insect attractant
11	25.148	4.15	Zingiberene	$C_{12}H_{24}$	204	Carminative, Antiemetic, Spasmolytic, Peripheral circulatory stimulant, and Anti-inflammatory, Anti-cancerous
16	25.941	.35	Chamigrene	$C_{15}H_{24}$	204.35	Antimicrobial and Antialgal activities
17	26.540	5.09	Acetyleugenol	$C_{12}H_{14}O_3$	206	Antibacterial and Antifungal Properties
18	26.540	0.64	Acetyleugenol	$C_{12}H_{14}O_3$	206	Antibacterial and Antifungal Properties
20	27.216	0.12	Propenoic acid	$C_{11}H_{16}O_2$	180	Use as an antifungal and also acts as an antimicrobial agent for food preservation and flavoring agent. It is a strong irritant to the skin, eyes, and mucous membranes and carcinogenic effects in humans.
21	27.405	0.15	Caryophllane oxide	$C_{15}H_{24}O$	220.36	Anti-inflammatory, Anti-carcinogenic, Anti-microbial, Anti-oxidative and analgesic activities and it have been used as flavoring agents.
22	28.026	.24	Widdrol	$C_{15}H_{26}O$	222.37	Antitumor, Antimicrobial and diuretic properties
23	28.220	1.00	Panthenol	$C_{15}H_{24}O$	220	Antimicrobial, Antiproliferative, Anti-inflammatory, and Immunomodulatory activities
24	28.866	0.35	Benzoic acid	$C_{17}H_{26}O_2$	262.38	Used as antimicrobial preservative in food and beverages, especially in carbonated beverages, strongest antibacterial activity excessive intake of BA may cause diarrhea, abdominal pain, and other symptoms
25	28.980	0.12	Humulene epoxide I	$C_{15}H_{24}O$	220.35	Anticancer activity, Anti-inflammatory effects
26	29.090	0.34	Pogostole	$C_{15}H_{26}O$	222.36	Antifungal and anti-inflammatory
27	29.268	0.45	Humulene epoxide I	$C_{15}H_{24}O$	220.35	Anticancer activity, Anti-inflammatory effects
28	29.488	0.23	1H-Cyclobut[e]inden-5-ol	$C_{15}H_{26}O$	222.36	Anti-tumor

29	29.717	0.41	Caryophyllane	$C_{15}H_{26}O$	222.36	Non-steroidal anti-inflammatory drug, a fragrance, a metabolite and an insect attractant
31	29.886	0.58	Propanone	$C_{15}H_{24}$	204.35	Used as an acne treatment and chemically exfoliate the dry skin
32	30.280	1.01	Arachidonic acid	$C_{20}H_{32}O_2$	304	It helps in growth, development, and a precursor of numerous lipid mediators.
34	30.557	0.94	Spathulenol	$C_{15}H_{24}O$	220	Antimicrobial, Antiproliferative, Anti-inflammatory, and Immunomodulatory activities
43	31.737	1.34	Anisylacetate	$C_{10}H_{12}O_3$	180	Used as a fragrance in cosmetics and non-cosmetic products such as household cleaners and detergents
45	32.077	0.37	Ether	$C_{11}H_{20}O$	168	**Used as a Perfuming and Flavoring Agent:**
54	32.929	0.42	Myristic acid	$C_{17}H_{34}O_2$	270.5	Anti-inflammatory and Antinociceptive properties
62	33.681	0.29	Pentadecanol	$C_{16}H_{32}O$	228.41	Used as an anti-acne agent and also as antimicrobial and dermatomycotic
70	34.787	0.55	Palmitic acid	$C_{16}H_{32}O_2$	256.42	Anti-inflammatory and lipid-lowering effects and also helps in rashes, irritation, redness, dryness and insect bites
76	36.557	0.59	Bacteriochorophyll-c-stearyl	$C_{52}H_{72}MgN_4O_4$	840	Antibacterial effect
84	38.041	0.23	Stearic acid	$C_{18}H_{36}O_2$	284	Moisturizing and Anti-inflammatory properties.
105	41.952	0.41	Phenol	$C_{23}H_{32}O_2$	340	Antioxidant, Anti-inflammatory, Skin brightening, Collagen protecting, UV protection and Regenerating
112	43.011	1.51	Anethole	$C_{10}H_{12}O$	148	Antimicrobial properties and promising insecticide
113	43.349	2.56	Phthalic acid	$C_{24}H_{38}O_4$	390	Mainly used *in gastrointestinal drug*
115	43.572	0.10	Pyrolo[3,2-d] pyrimidin-2	$C_6H_5N_3O_2$	151	Antimicrobial, Antibacterial, Antifolate, Anticonvulsant, Antileishmanial, Anti-inflammatory, Anti-aggressive, Antiviral, Anticoagulant, Antioxidant, Antifungal, Anti-asthmatic
138	46.459	0.90	Acepromazine	$C_{19}H_{22}N_2OS$	326	Antiemetic, Antihistaminic, Antisympathetic, Antiarrhythmic, and Antishock properties

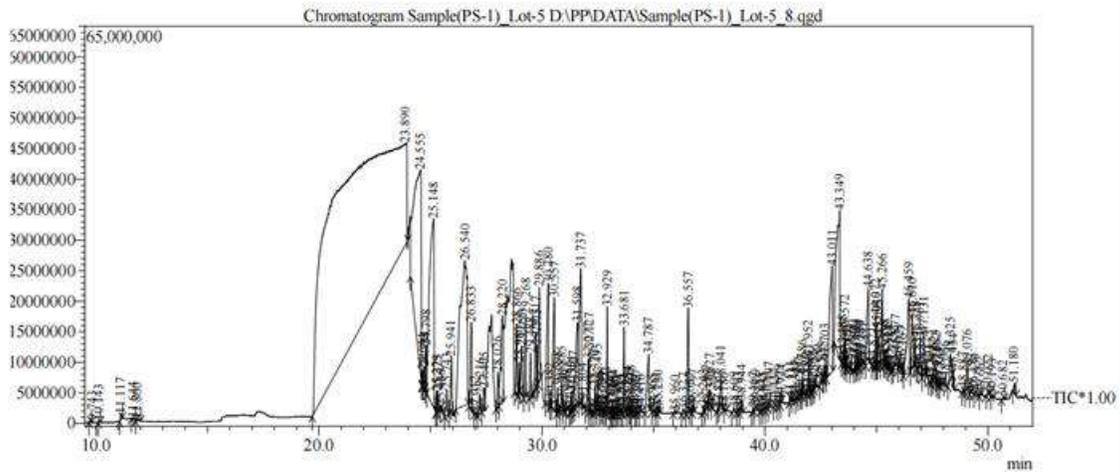| 139	46.610	0.46	2- Benzenol	C16H19NO3	273.33	Used to disinfect skin and to relieve itching and also used as an oral analgesic or anesthetic

Fig-1 Chromatogram of AFOs and Clove oil with peaks for various bioactive constituents

RESEARCH ARTICLE

Flare-Induced Transverse Oscillations of Coronal Loops and Propagating EUV Waves

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ABSTRACT

We study an X1.5 class solar flare observed from an active region NOAA 13006 on May 10, 2022. This flare was accompanied by other energetic activities such as the propagation of an Extreme Ultraviolet (EUV) wave, coronal loop oscillations, Coronal Mass Ejections (CMEs), etc. We analyze this event using high spatial and temporal resolution observations from the Atmospheric Imaging Assembly (AIA) on board the Solar Dynamics Observatory (SDO), Extreme-Ultraviolet Imager (EUVI) of the Solar Terrestrial Relations Observatory-Ahead (STEREO-A), and the Large Angle and Spectrometric Coronograph (LASCO) within the Solar and Heliospheric Observatory (SOHO) satellites. We found that the EUV waves are initiated at the start of the flare, i.e., they are driven by the solar flares. It consisted of both fast and slow wave components. These shock wave fronts create oscillations in the bundle of coronal loops. One of the loops studied further to estimate the oscillation parameters. This loop oscillated with a period of 5.3 minutes with a damping time of 14±1 minutes. After that, we evaluated the oscillated coronal loop length by combining observations from AIA/SDO and EUVI/STEREO-A. Then, we estimated the magnetic field strength as 68 G with the help of coronal seismology.

Keywords: Corona, Structures; Flares, Waves; Magnetic fields, Corona; Waves, Magnetohydrodynamic; Waves, EUV Waves; Waves, Shocks

INTRODUCTION

Coronal loops are considered as closed magnetic flux tubes rooted in the photosphere. They can be an effective medium for waves and oscillatory activities [3]. These waves and oscillations can be triggered in various ways, such as by energetic events (e.g., solar flares, CMEs), the eruption of a flux tube, or the ejection of a plasmoid [39], flare-induced shocks [25,19], and reconnection due to nearby loop interactions [31]The EUV waves are referred to by

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different names such as Extreme-ultraviolet Imaging Telescope (EIT) waves, since they are clearly observable in EUV wavelengths. They manifest as coronal propagating fronts, shock waves, or coronal waves [14]. The EUV waves are known as fast-mode magnetoacoustic waves [12,18], They are also treated as pseudo-waves [12]. These waves create successive bright and density enhancements while propagating through the solar disk at a typical speed of 100 km/s to thousands of km/s. They can generate Moreton waves and fast-mode MHD shocks. EUV waves are mainly associated with filament eruptions and CMEs rather than solar flares [37,32]. During the observation and analysis of EUV waves, one can observe propagating stationary wave fronts [14], non-wave components such as filament or coronal loop oscillations [10]. These waves reflect when reaching coronal holes or active regions [37,17] and are also refracted into varying density plasma [20]. The oscillatory patterns observed in the coronal loops, filaments, or prominences created by flare-driven shocks or EUV waves are studied by many researchers such as [25,4,33].

They confirmed that these waves and oscillations are either high amplitude rapidly decaying or low amplitude decayless oscillations [2,27]. Among these, Transverse Loop Oscillations (TLO) in the fundamental mode are mostly observed [4,26]. However, harmonics can also be seen [36,15]. The first analysis of TLOs with the observations from the Atmospheric Imaging Assembly (AIA)on board the Solar Dynamics Observatory (SDO) was performed by[7]. The oscillatory parameters (period, damping time, phase, etc.) and the theoretical model of the coronal loop oscillations help us to deduce the physical parameters such as magnetic field strength, density, etc., of the coronal plasma [30,24]. However, the density and the magnetic field value continuously vary along coronal loops. Thus, the parameters estimated with this tool might differ from the actual values [7]. [1] mentioned that the stratification of these parameters has to be included for reliable values. Still, it is difficult to evaluate the density contrast directly[5]. The density values can be measured using the Differential Emission Measure (DEM) method. The DEM is also used to evaluate the temperature of coronal plasma [38]. By applying this method to the AIA passband, [3] estimated the magnetic field seismologically. In this paper, we observe and analyze EUV wave properties, solar flares, associated CME, and coronal loop oscillation induced by the shocks from the flare site on May 10, 2022, seen in the active region NOAA 13006. The rest of the paper is arranged as follows. Section 2 discusses the observational data used. Section 3 deals with analysis and results. Finally, section 4 provides a summary and conclusions.

OBSERVATIONAL DATA
We use observations from AIA/SDO, EUVI/STEREO-A/B, and SOHO/LASCO for the analysis. The AIA has seven extreme ultraviolet (EUV) band passes. One of them is 304Å, whose emission is from He II at a temperature of T=0.05MK. The other six EUV wavelengths have iron emission bands: 171Å from Fe IX at T=0.63MK, 131Å from Fe VIII at T=0.37MK, Fe XX at T=9.1MK and Fe XXIII, 94Å from Fe XVIII at T=6 (6.3)MK, 193Å from Fe XII at T=1.4MK and Fe XXIV at T=19MK, 211Å from Fe XIV at T=2 (1.9)MK, 335Å from Fe XVI at T=2.5 (2.7) MK [28,22]. It provides continuous full-disk images of the Sun with a temporal cadence of 12 second, pixel resolution of $0''.6$, and a spatial resolution of $1''.5$. We used the Geosynchronous Operational Environmental Satellites (GOES) observations in the 0.5–4.0Å and 1.0–8.0Å wavelength bands to understand the energetics of flaring events in X-rays. One can check the association of CMEs with the selected flaring events by combining observations from the SOHO/LASCO [9] CME Catalog[16] and Computer-Aided CME Tracking (CACTus - a software package) CME list [29]

ANALYSIS AND RESULTS
EVENT DETAILS
The active region (AR) NOAA 13006 is observed at 31° south and 9°west of the solar disk on May 10, 2022, as shown in Figure 1(a). The GOES X-class flare flux profile in Figure 2 shows that the X1.5 flare started at 13:50UT, peaked at 13:55UT, and ended at 13:59UT. This flare was associated with a propagating EUV wave and a CME, as shown in Figure 3. The EUV wave started at 13:21UT and ended at 14:59UT. Similarly, from the SOHO/LASCO CME catalog, the flare and EUV wave-associated CME started at 14:36UT with a position angle of 124 °and a velocity of 414.7km/s, then accelerated to -3.98m/s². Therefore, the data duration is taken as May 10, 2022, 13:15 to May 10, 2022, 15:00 in the SDO/AIA 171Å intensity images.

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PROPAGATION OF THE EUV WAVES

We observed a propagating shock wave in all directions across the solar disk from the flare site, as marked with red cross in Figure 1(a). Primarily, it propagated towards the south part of the solar disk. To study the kinematics and their role in the initiation of loop oscillations, we considered 20 slits starting from the flare site and extending towards the direction of propagation (Figure 1(a)). Subsequently, we created time-space intensity maps of the wave propagation along these 20 slits. The primary shock wave fronts are observed in slits 1-4, 9-10, 12, and 18-19. However, more wave fronts are clearly visible in slits 5-8, 11, and 13-17 (for an example, see Figure 1(b) and (c)). Thus, from the computed time-space map of the propagating shock wave front along slits 14 and 16, as shown in Figure 1(b) and (c), the white dotted lines numbered from 1 to 5 represent the positions of the fast and slow wave fronts, and the crossed oscillatory patterns depict the coronal loops further used for the oscillation studies. For the calculation of the wave front speed, we visually inspected the edges of the wave front and manually marked the wave front position, as seen by the white dotted lines. Subsequently, we performed a quadratic fit to the wave front positions, as shown in Figure 1(d). This allowed us to obtain the speed of both the fast and slow components of the shock wave (see Table 1). The velocity range for the fast wave component is 1000km/s, while the slow wave has a velocity range of 100 – 350km/s. Both the fast and slow components can be observed in Figure 1(b) and (c). Notably, the maximum velocity of the fast wave front is along the slit 14 direction. Thus, we confirmed, following [11], that the primary wave front is the fast component of the shock wave, observed in all 20 slit directions, while the remaining wave fronts are the slow components, only observed in slits 5-8, 11, and 13-17. From the time-space intensity map in Figure 1 along slits 14 and 16, and the bottom panel of Figure 2, we observe that this shock wave initiated simultaneously with the solar flare, reached the coronal loops, and triggered oscillations in the bundle of loops.

EUV WAVES AND CME RELATION

The SOHO/LASCO observations (see top panels of Figure 3) indicate that this event is associated with a partial halo CME which starts at 14:36UT in the C2 field-of-view (FOV) with a position angle of 124° and an angular width of 159°. In Figure 3, the top panel represents the SDO/AIA and SOHO/LASCO/C2 observations before the CME started, where we can observe the EUV wave front on the solar disk at 14:03UT (left-top panel) and the peak of the CME at 16:24UT (top right-bottom panel). The bottom panel shows the propagation of the CME along with the solar height, where crosses represent the height with time, and the solid curve gives the fitted values. Figure 2 provides a relation between the flare, shock wave, and CME initiation. This illustrates that shocks initiated along with the flare, and the CME started after the end phase of the flare. It is certain that the shocks are initiated along with the flare. However, we are not certain whether the solar flare or the coronal wave/shocks triggered the CME. Thus, it seems that the flare causes the initiation of the CME and its propagation.

SHOCK WAVE INDUCED CORONAL LOOP OSCILLATIONS

In order to analyze the shock wave (fast component)-induced coronal loop oscillations, distinct loops are identified from a bundle of oscillating coronal loops in the time-space map in the AIA 171Å intensity (see Figure 1(a) and (b)). We then select one oscillating loop L_2 with a sufficient number of oscillation cycles and distinguishable ability from nearby loops. To study the oscillation properties of L_2, we choose 10 slits perpendicular to the plane of oscillation, as shown in the top-left panel of Figure 4. Subsequently, time-space maps along these 10 slits are determined by joining intensity values along each slit as a function of time. The top-right panel of Figure 4 displays the time-space intensity maps along slits 4, 5, and 6, where crosses represent the mean position of the loop. The shock fronts propagating across the loop oscillation are clearly observed. Confirming that the wave amplitude decreases as it propagates, we identify a decaying oscillation along slits 4, 5, and 6, chosen for showing more than three clear cycles of oscillation patterns. Subsequently, we create the time series of loop oscillation along these slits by taking intensity as a function of time from the time-space map. To calculate the oscillated coronal loop length, we employ two methods. First, we manually inspect the loop location in the AIA 171Å intensity imagery and confirm these positions by tracking the loop's intensity in the time-space map. This process is repeated ten times to obtain more accurate loop positions. Mean and standard deviation values are taken as the loop position and error in the calculation, respectively (for

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references, see papers [8,21]). The mean values, represented by crosses in the top-left panel of Figure 4, are used to determine the foot points of the loop, visible just before the oscillation starts. The loop length is then evaluated according to [6], considering the loop position and the location of its foot points. The projected coronal loop length is estimated as L_2 = 305 ±3 Mm. Secondly, we compare EUVI/STEREO and AIA/SDO observations, including both STEREO A and B [21],[36]. Using stereoscopy, we observe the oscillated coronal loop from two different viewpoints and construct a three-dimensional view of the loop. This method provides a more accurate loop length compared to a projected image value with errors. The stereoscopically deduced value of the coronal loop is L = 302.1Mm. Following this, the estimated mean positions of the coronal loops with time (see the top-right panel of Figure 4) are used to evaluate the oscillation parameters. In the bottom panel of Figure 4, a linear trend is subtracted from the time series of the loop, and the resulting time series is fitted with an exponential damping cosine function of the form as shown below(see solid curves in bottom (b) panel of Figure 4),

$$(t) = A_0 \cos\left(\frac{2\pi(t-t_0)}{P} + \phi\right) \exp\left(-\frac{t-t_0}{\tau}\right) + A_1 + A_2(t - t_0)\,(1)$$

where A_0, P, ϕ, τ, and t_0 represent the amplitude, period, phase, damping time, and reference time of oscillation, respectively. Additionally, A_1 and A_2 are linear constants related to the amplitude. The fitting was performed using MPFITFUN in the Interactive Data Language (IDL) with the Levenberg–Marquardt least-squares minimization method[23]. However, this method did not fit well with the mean position of the loops. Consequently, we determined the Fourier power spectra (FPS) of the time series (see panel (c) of the bottom of Figure 4) to obtain a more accurate period of the oscillation. We computed the FPS for the remaining slits. The oscillation parameters derived from the mentioned methods are tabulated in Table 2. From Table 2, the L_2 loop oscillates with an amplitude of ≈ 26±6 Mm, a period of 5.3 minutes, and a damping time of 14±1 minutes. The errors in the measurements may primarily be due to the error in the estimated loop position. The single peak in the FPS indicates that L_2 is in the fundamental mode of oscillation. To confirm this, we analyzed the cross spectra and the phase spectra with the time series along different slits, as mentioned in [8]. We concluded that L_2 oscillates in the fundamental mode, as there is no significant phase difference for the slit positions of the coronal loop. Furthermore, one can estimate the kink speed C_K, Alfven speed V_{A0}, and the magnetic field strength B by using the stereoscopically deduced loop length and the period of oscillation. For a fundamental mode, the loop length L and period P of oscillation can be related to the phase speed v_{ph} of the wave as [30,25]

$$v_{ph} = \frac{2L}{P}\,(2)$$

Then, the magnetic field strength inside of a coronal loop can be estimated (for more details refer the paper [8])[30,25],

$$B = V_{A0}\sqrt{\mu_0\mu_c m_p n_e}\,(3)$$

where V_{A0} is the Alfven speed, μ_C=1.27 is the mean molecular weight in the corona, and m_P is the proton mass. The electron density n_e in the coronal plasma can be taken as $(7-10)\times10^9 cm^{-3}$[34]. Thus, the estimated coronal parameters are listed in Table 3. However, the density and magnetic field values vary along a loop. Therefore, coronal seismology provides an average value of the magnetic field inside an oscillating coronal loop [7]. One can evaluate the temperature distribution of the loops and density contrast by using the differential emission measure (DEM) method and more accurate magnetic field values with nonlinear force-free field (NLFFF) extrapolation methods

SUMMARY AND CONCLUSIONS

The EUV wave nature and its induction of transverse coronal loop oscillation are analyzed using observations from SDO/AIA 171Å intensity images, SOHO/LASCO/C2 field of view, and STEREO-A/EUVI 195Å images on May 10, 2022, in the AR NOAA 13006. From the shock wave analysis, it is evident that there is a fast mode and a slow mode component for the shock wave front or EUV waves [13]. The speed of the fast component is in the range of 1000 km/s, while that of the slow mode ranges from 100 to 350 km/s. The speed of the slow component depends on the nearby magnetic field configuration. Typically, EUV waves originate from solar flares, filament eruptions, or CMEs.

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In this case, the shocks emerge at the onset or the start of the flare, indicating a flare-driven shock wave propagation, with the CME starting after the end phase of the flare. As the fast component of the shock wave propagates in all directions, especially towards the south part of the solar disk, it can cause oscillations in the bundle of coronal loops. Therefore, we analyzed the oscillation properties and plasma parameters of the shock wave-induced coronal loops. We found that the loop oscillated with an average period of 5.3 minutes, an amplitude of $\approx 26\pm6$ Mm, and a damping time of 14 ± 1 minutes. Fourier power spectra and phase analysis confirmed that the loop is in the fundamental mode of oscillation, with different parts of the loop oscillating in phase. The projected coronal loop length was estimated as 305 ± 3 Mm using a method discussed by [6]. The stereoscopically measured loop length is $L=302.1\pm0.1$ Mm. The errors in the measurements may be due to the loop position and other factors. Subsequently, the magnetic field in the coronal loop is deduced from the values of the period of oscillation and the more accurate loop length, obtaining a field value of ≈ 68 G.

ACKNOWLEDGMENT

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Table 1 Shock wave front speed along the numbers 1 to 5 mentioned in Figure 1(b) and (c).

Slit. No.	Wave front speed (km/s)				
	1	**2**	**3**	**4**	**5**
14	1177	350	258	223	112
16	1000	284	193	146	-

Table 2 Oscillation parameters of the coronal loop L_2 across different slits

Slit No.	Amplitude	Period from Damp fit P_1	Damping time τ	Period from power spectra P_2
	(Mm)	(minute)	(minute)	(minute)
4	19±2	5.20	15±1	5.3
5	31±4	5.20	12.2±0.6	5.3
6	26±2	5.10	14.1±0.7	5.3

Table 3 Physical parameters of the coronal loop

$Lproj = L2$	$Ltrig = L$	C_k	V_{A0}	B
(Mm)	(Mm)	(km/s)	(km/s)	(G)
305±3	302.1±0.1	1944	1442	68
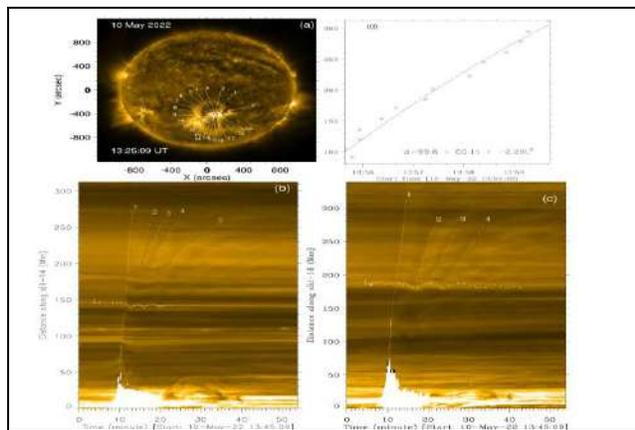
Figure 17 (a) Full disk image on May 10, 2022, at 13:25 UT in the AIA 171Å intensity, where white solid lines represent the 10 slit positions further used for the coronal wave analysis. (b) and (c) are the time-space intensity maps along slits 14 and 16 in the MN direction, as seen in panel (a), where the white dotted lines represent the coronal wave propagation direction numbered from 1 to 5, and the white crosses mark the coronal loop positions. (d) provides the least square quadratic fit along the wave propagation position along slit 16, numbered as 1.	Figure 18 Relationship between the solar flare, shock wave front, and CME. The dashed black line represents the shock wave front position along slit 16, as seen by the dotted white line numbered as 1 in Figure 1(b). The plus sign and dotted blue line depict the CME propagation height from the solar surface, and the red curve represents the normalized AIA 171Å intensity.

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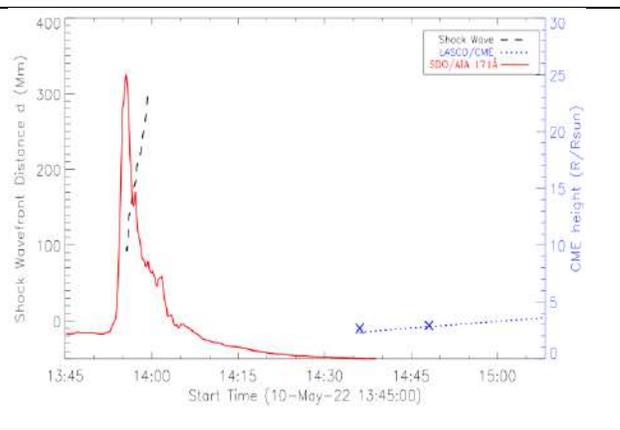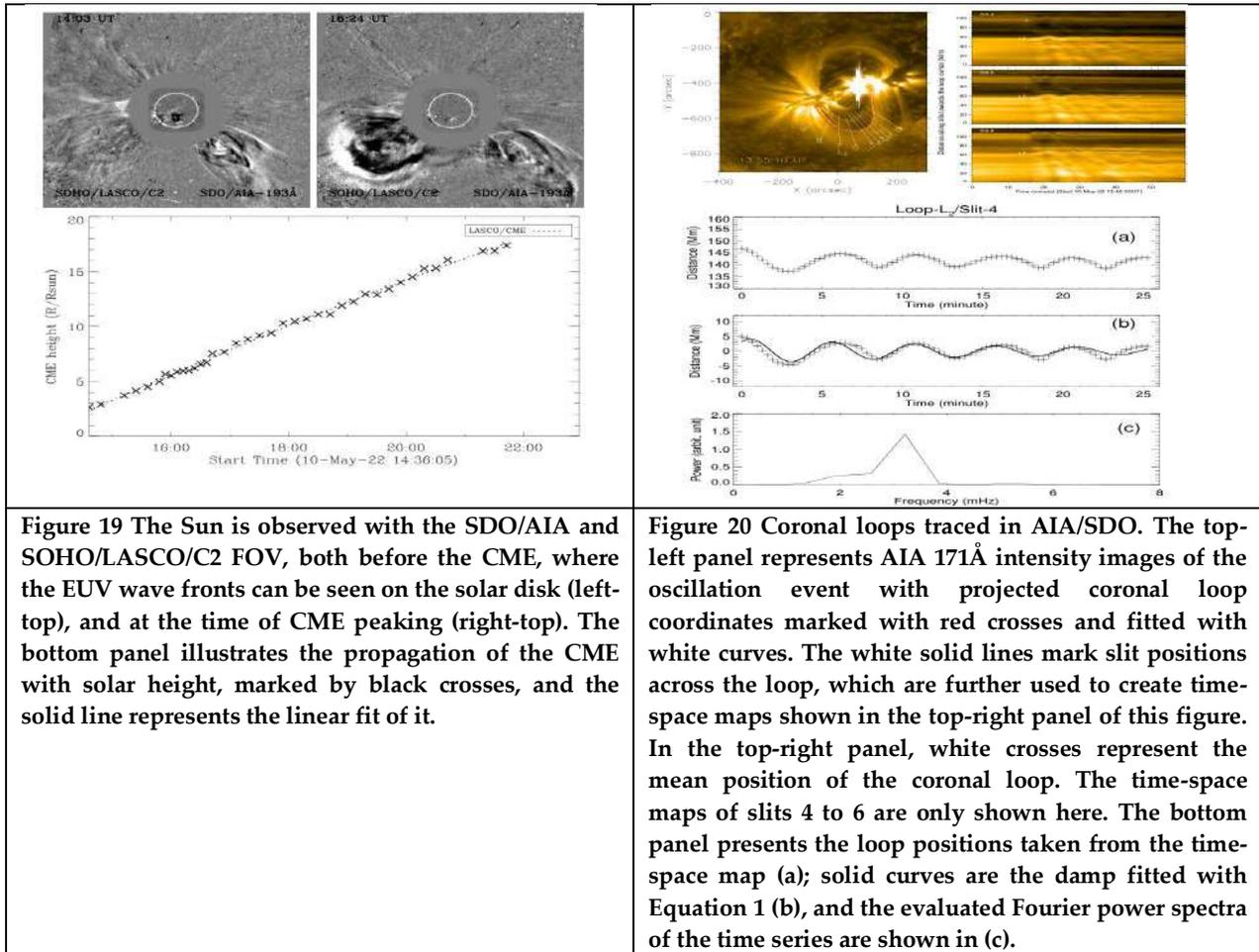**Figure 19 The Sun is observed with the SDO/AIA and SOHO/LASCO/C2 FOV, both before the CME, where the EUV wave fronts can be seen on the solar disk (left-top), and at the time of CME peaking (right-top). The bottom panel illustrates the propagation of the CME with solar height, marked by black crosses, and the solid line represents the linear fit of it.**

Figure 20 Coronal loops traced in AIA/SDO. The top-left panel represents AIA 171Å intensity images of the oscillation event with projected coronal loop coordinates marked with red crosses and fitted with white curves. The white solid lines mark slit positions across the loop, which are further used to create time-space maps shown in the top-right panel of this figure. In the top-right panel, white crosses represent the mean position of the coronal loop. The time-space maps of slits 4 to 6 are only shown here. The bottom panel presents the loop positions taken from the time-space map (a); solid curves are the damp fitted with Equation 1 (b), and the evaluated Fourier power spectra of the time series are shown in (c).

REVIEW ARTICLE

Difference Arithmetic Geometric Mean Index of Graphs

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ABSTRACT

In this paper, the concept of difference arithmetic geometric mean index of a graph G denoted by DAGM (G) is introduced and the difference arithmetic geometric mean index DAGM(G) of few families of graphs is computed. Further, we establish correlation and regression of physico-chemical properties of isomers of octane using difference arithmetic geometric index are investigated.
Subject Calssification : 05C07, 05C09, 05C90

Keywords: Molecular graph, isomers of octane, correlation, Difference arithmetic geometric index of graphs

INTRODUCTION

Graph theory is one of the branches of Mathematics having most magnificent development in recent years. It is the study of relationship between vertices and edges. It provides a helpful tool for quantifying and simplifying the many moving parts of dynamic systems. Studying graphs through a framework provides answers to many arrangements, networking, optimization, matching and operational problems. Graphs can be used to model many types of relations and processes in physical, biological, social and information systems, and it has a wide range of useful applications.

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Preliminaries

Some known definitions and results related to difference arithmetic geometric mean index ofgraphs for ready reference to go through the work presented in this paper are discussed in this section.

Def 2.1 Let G = (V, E) be a graph with vertex sets V(G) and edge sets E(G). The geometric – arithmetic mean index is defined as $GA(G) = \sum_{uv \in E(G)} \frac{2\sqrt{d_u d_v}}{d_u + d_v}$ where d_u and d_v are the degrees of end-vertices of an edge uv

Def 2.2 Let G = (V,E) be a graph with vertex sets V(G) and edge sets E(G). The arithmetic geometric mean index is defined as $AG(G) = \sum_{uv \in E(G)} \frac{d_u + d_v}{2\sqrt{d_u d_v}}$ where d_u and d_v are the degrees of end-vertices of an edge uv

Def 2.3 Let G = (V,E) be a graph with vertex sets V(G) and edge sets E(G). The harmonic index of a graph is defined as $H(G) = \sum_{uv \in E(G)} \frac{2}{d_u + d_v}$ where d_u is the degree of vertices.

Def 2.4 The general Randic index of a graph was proposed by Bollobas and Erdos and is defined as
$$R_\propto (G) = \sum_{uv \in E(G)} (d_u d_v)^\propto$$

Def 2.5 Let G = (V,E) be a graph with vertex sets V(G) and edge sets E(G). The sum connectivity index of a graph is defined as $\chi(G) = \sum_{uv \in E(G)} \frac{1}{\sqrt{d_u + d_v}}$

Difference Arithmetic Geometric Mean Index

Motivated by the definition of arithmetic geometric index, **Difference arithmetic geometric mean index (DAGM(G))** of a simple graph G is defined. Also, Difference arithmetic geometric mean index of the standard graphs are found.

Definition3.1 Difference arithmetic geometric mean index of graph G, denoted by DAGM (G) is defined as
$DAGM(G) = \frac{d_u + d_v}{2} - \sqrt{d_u d_v}$ for all u, v belongs to V(G)

Remark

It is known that, for all the same data Arithmetic Mean = Geometric Mean.
For any k – regular graph G, $d_u = k$, for all u, v belongs to V(G). In this case,
clearly DAGM (G) = 0.
From this remark, it follows that the DAGM(K_n) = 0

Theorem 3.2: For the complete bipartite graph$K_{m,n}$, the DAGM index is
$DAGM (K_{m,n}) = \frac{mn(m+n)}{2} - (mn)^{\frac{3}{2}}$

Proof Let V $(K_{m,n}) = V_1 \cup V_2$ where V_1 and $V_2$are the partitions of V such that every vertex u belongs to $V_1$is adjacent to every vertex v belongs to V_2. Note that d(u) = n, d(v) = n. Also, $|E (K_{m,n})| = mn$
$$DAGM(G) = \frac{d_u + d_v}{2} - \sqrt{d_u d_v}$$
$DAGM (K_{m,n}) = \frac{mn(m+n)}{2} - (mn)^{\frac{3}{2}}$

Corollary For the star graph K $_{1, n-1}$,the DGAM index is $\frac{n(n+1)}{2} - (n-1)^{\frac{3}{2}}$

It follows from the above theorem by replacing m by 1, n by n-1

Theorem 3.3 For the cycle graph C_n, n ≥ 3, the DGAM index is zero.

Proof Since C_n is a regular graph of order2, For any k – regular graph G, $d_u = k$, for all u, v belongs to V(G). Obviously DAGM (G) = 0.
$$DAGM(G) = \frac{d_u + d_v}{2} - \sqrt{d_u d_v}$$
$DAGM(Cn) = 0$

Theorem 3.4 For the path graph P_n , n≥3, the DAGM index is $3 - 2\sqrt{2}$
Proof Let V(P_n) = {$v_1, v_2, \dots v_n$} , |E (P_n) | $= n - 1$
Note that d(u_1) = d(u_n) = 1 and d(u_i) = 2 for $2 \le i \le n - 1$

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$$DAGM(G) = \frac{d_u + d_v}{2} - \sqrt{d_u d_v}$$

DAGM (P_n) = $3 - 2\sqrt{2}$

Theorem 3.5 For the wheel graph, W_n, $(K_1 + C_n)$, $n \geq 4$, the DAGM index is equal to

$$\frac{(n-1)(n+2)}{2} - \sqrt{3}\,(n-1)^{\frac{3}{2}}$$

Proof Let $V(W_n) = \{v_1, v_2 \dots v_n\}$ and $E(P_n) = \{e_1, e_2 \dots e_{2n-2}\}$

By the edge partition of W_n on the basis of the degrees of the vertices of each edge, there are two types of edges and the number of edges is $n-1$ in each type.

$$DAGM(G) = \frac{d_u + d_v}{2} - \sqrt{d_u d_v}$$
$$= (n-1)\left(\frac{3+3}{2} - \sqrt{9}\right) + (n-1)\left(\frac{3+n-1}{2} - \sqrt{3(n-1)}\right)$$
$$= \frac{(n-1)(n+2)}{2} - \sqrt{3}\,(n-1)^{\frac{3}{2}}$$

Theorem 3.6 For the friendship graph F_n, for an integer $n \geq 2$, the DGAM index is

2n (n + 1) - $4n\sqrt{n}$

Proof Let $V(F_n) = \{v_1, v_2 \dots v_{2n+1}\}$ with v_1 as the centre vertex.

$E(F_n) = \{v_1 v_i / 2 \leq i \leq 2n+1\} \cup \{v_{2i} v_{2i+1} / 1 \leq i \leq n\}$

By using the edge partition of F_n, on the basis of the degrees of the vertices of each edge, there are two types of edges namely n and 2n

$$DAGM(G) = \frac{d_u + d_v}{2} - \sqrt{d_u d_v}$$

$DAGM(F_n) = $ 2n (n + 1) - $4n\sqrt{n}$

Theorem3.7 For the double star graph $S_{m,n}$ for an integer m, n ≥ 3, the DGAM index is DGAM

$$S_{m,n} = \frac{p^2 + q^2 + p + q - 2}{2} - \sqrt{p}(p-1) - \sqrt{q}(q-1) - \sqrt{pq}$$

Proof Let $V(K_{1,n,n}) = \{u\} \cup \{v_1, v_2, \dots, v_n\} \cup \{w_1, w_2, \dots, w_n\}$. By using the edge partition of $S_{m,n}$ on the basis of the degrees of the vertices of each edge, there are three types of edges,

$d(u_0) = p$, $d(u_1) = 1$, number of edges = $p - 1$, $d(v_0) = q$, $d(v_1) = 1$, number of edges = $q - 1$

$d(v_0) = P$, $d(v_0) = q$; number of edges = 1

$$DAGM(G) = \frac{d_u + d_v}{2} - \sqrt{d_u d_v}$$

$$DAGM(S_{m,n}) = (p-1)\left(\frac{p+1}{2} - \sqrt{p}\right) + (q-1)\left(\frac{q+1}{2} - \sqrt{q}\right) + \left(\frac{p+q}{2} - \sqrt{pq}\right)$$

Therefore, $DAGM(S_{m,n}) = \frac{p^2 + q^2 + p + q - 2}{2} - \sqrt{p}(p-1) - \sqrt{q}(q-1) - \sqrt{pq}$

Applications of the DGAM index of a graph in chemistry

Different organic molecules of organic compounds have different properties based upon their structure such as the Cycloalkanes. Cycloalkanes are the class of hydrocarbons having a ring-like structure. This ring is formed due to their saturated nature, and they have three compounds of alkane present in the structure which helps them in forming a ring. They have the general formula C_nH_{2n}, where n is said to be the number of carbon atoms present in the organic compound.

Revathy

DAGM index of Octane isomers

In this section, the DAGM index of various octane isomers are calculated. It is compared with the existing boiling point, entropy, density of various octane isomers. The topological indices for 3 – Methyl heptane and 4 – Methyl heptane are same.

DAGM index of cycloalkanes.

A cycloalkane has n carbon atoms and 2n-2 hydrogen atoms is denoted by C_n^{2n-2}. The molecular graphs of them are obtained by attaching 2n – 2 pendant vertices corresponding to hydrogen atoms to vertices of a cycle corresponding to carbon atoms

Theorem 5.1 For $n \geq 3$, the DAGM index is equal to DAGM $(C_n^{2n-2}) = n + 9 - 6\sqrt{3}$

Proof The cycloalkane molecular graph C_n^{2n-2} has $3n – 2$ vertices including two vertices (namely C_1 and C_2) of degree three, $n – 2$ vertices C_3, C_4,……….C_n of degree 4 and correspond to the carbon atoms of cycloalkenes and the remaining $2n – 2$ vertices (namely H's) are end vertices and they correspond to hydrogen atoms of cycloalkenes. Thus, on the basis of degrees of the vertices, we divide the edge set into partitions.

$E_1 = \{uv \in E(C_n^{2n-2}) / d(u) = d(v) = 4\}$, $E_2 = \{uv \in E(C_n^{2n-2}) / d(u) = d(v) = 3\}$

$E_3 = \{uv \in E(C_n^{2n-2}) / d(u) = 3; d(v) = 4\}$, $E_4 = \{uv \in E(C_n^{2n-2}) / d(u)=1;\ d(v) = 3\}$

$E_5 = \{uv \in E(C_n^{2n-2}) / d(u) = 1; d(v) = 4\}$

There are 5 types of edges where $|E_1| = n – 3$, $|E_2| = 1$, $|E_3| = 2$, $|E_4| = 2$, $|E_5| = 2n – 4$

$$DAGM(G) = \frac{d_u + d_v}{2} - \sqrt{d_u d_v}$$

$$DAGM(C_n^{2n-2}) = n + 9 - 6\sqrt{3}$$

CONCLUSION

In this paper, the concepts of difference arithmetic geometric means index of some standard graphs are computed. Also, difference arithmetic geometric means index of a graph in chemistry is discussed.

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Table 1. DAGM index of Octane isomers

n	Octane's	Boiling point	Entropy	Density	DAGM(G)
1	n - octane	125.7	111.67	0.703	0.172
2	2 – Methyl heptane	117.6	109.84	0.698	0.673
3	3 – Methyl heptane	118.9	111.26	0.702	0.542
4	4 – Methyl heptane	117.7	109.32	0.705	0.542
5	2, 2 – dimethyl hexane	106.8	103.42	0.695	1.758
6	3, 3 – dimethyl hexane	112	104.74	0.710	1.516
7	2, 3 – dimethyl hexane	115.6	108.02	0.691	2.941
8	2, 4 – dimethyl hexane	109.4	106.98	0.696	1.34
9	2, 5 – dimethyl hexane	109.1	105.72	0.691	1.174
10	3, 4 – dimethyl hexane	117.7	106.59	0.715	0.81
11	2,3,4 trimethyl pentane	113.5	102.39	0.719	1.34
12	2,2,3 trimethyl pentane	109.8	101.31	0.716	1.941
13	2,2,4 trimethyl pentane	99.24	104.09	0.688	1.991
14	2,3,3 trimethyl pentane	114.8	102.06	0.726	1.83
15	2,2,3,3tetramethyl butane	106.5	93.06	0.824	3
16	2-methyl-3-ethyl pentane	115.6	106.06	0.719	0.81
17	3-methyl-3-ethyl pentane	118.3	101.48	0.727	0.274
18	3 – ethyl hexane	118.5	109.43	0.714	0.411
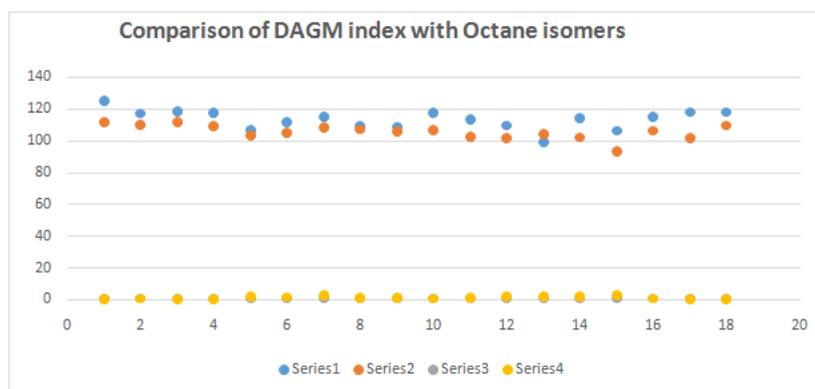
Fig.1. Comparison of DAGM index with Octane isomers

RESEARCH ARTICLE

Review of Emerging Technologies for India's Sustainable Smart Cities

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ABSTRACT

Urban development and smart urban communities embody two ideal models of development that emerged in the previous century in response to cities' aspirations to be more responsive to the needs of their inhabitants, create conditions that promote a high quality of life, and foster sustainability in an increasingly globalized world. The recognition that excessive resource consumption brings humanity closer to a future where essential goods may become scarce for large segments of the population, coupled with significant technological advancements in resource conservation, urban monitoring, and informed decision-making, has brought these two disciplines closer than ever before, despite their distinct developmental paths thus far. Numerous initiatives aimed at building smart cities seek to harness information and communication technologies (ICTs) to enhance the effectiveness, efficiency, transparency, and accountability of communications and transactions between the government and citizens. Given the pivotal role of ICTs in the planning of smart cities, a considerable amount of city investment is dedicated to the development of new technologies. Consequently, smart cities create and

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manage various innovative services that facilitate the dissemination of information pertaining to all aspects of citizens' lives through web-based and interactive applications. Smart cities possess several essential attributes: a smart economy, smart people, smart governance, smart mobility, smart environment, and smart living.

Keywords: Sustainable Smart Cities, Urban Development, Internet of Things (IoT), Big Data.

INTRODUCTION

Today, a wide array of sensors is being implemented worldwide to measure various variables both inside and outside of human-built homes. These sensors, coupled with actuators, are capable of performing complex tasks and are compatible with different platforms and contexts. The concept of smart cities has evolved to prioritize sustainability, citizen well-being, and economic development. The rapid urbanization and unplanned expansion of cities bring significant changes to economies at different levels—city, country, or region. Consider the consumption of water, fuel, and electricity, which leads to high levels of pollution, negatively impacting the lives of citizens, climate, and the environment. Cities have transformed into smart entities with the integration of various sensors, intelligent devices, energy meters, outlets, and appliances. This integration allows for unique and intelligent control over devices within homes. This paradigm shift brings sustainability and substantial savings, whether in terms of money or resources. While the ideal scenario envisions a web-based platform for processing information related to a single house in a fully-fledged smart city, achieving this nationwide is still a distant reality. To facilitate seamless operation, there is a need for standardized protocols across devices from different manufacturers. Such protocols would simplify device operation and reduce the need for advanced coding and time management skills.

Innovative concepts aid in identifying domain-specific technologies, protocols, and privacy data for IoT environments with specific purposes. Our research model addresses various issues related to smart home devices, including location determination and the provision of services. This ensures satisfactory performance in terms of time duration and power usage. Methods like buffering, caching, and event-triggered messaging facilitate the smooth operation of smart homes. The idea of connecting smart homes to the internet presents flexible solutions for managing power and converting energy forms. Our application can be extended to perform tasks such as energy management, exploring power-efficient rules for smart cities by connecting physical devices. In recent years, the Indian government has pledged to develop smart cities, and our goal is to provide a smart framework that enables not only the development but also the thriving of these smart cities. Information, derived from various sensors and analyzed by sophisticated analytical engines like PIG-based Bigdata applications, is the power that drives these cities. The upcoming era of smart cities relies on intelligent sensing power achieved through IoT frameworks, allowing communication not just between people but also with their homes and devices.

Different institutions are joining the discussion, educating state management and learning centers about the impact on the future economy, people's welfare, and service quality. State officials are exploring effective information and communication technology resources, uncovering opportunities for citizens to follow a progressive path. Transforming cities with sophisticated technology integrated into smart cities requires documenting policies, actions, projects, and programs into various modules. However, implementing this idea is challenging due to a lack of mature provisions and a focus on methods rather than groundwork and deployment. Smart cities, coined as such, should be transparent, easy to understand, responsive, and capable of coping with current and future technologies. Stakeholders in these cities must understand the environment, its manageability, adaptability, and flexibility to handle complex tasks. Effective management of such complex cities requires leadership and the ability to perform when necessary. Our research aims to test the practical implementation of a smart district and demonstrate how complementary elements can work together to create a simulation model for actual city development. We also aim to shed light on uncharacterized modules of smart cities, stakeholders' roles and responsibilities, unknown features,

and the deployment process. The idea of smart cities has captivated the Indian public and stakeholders in recent years. It represents a city that utilizes the latest information and communication technology for its development. Stakeholders' investments in smart cities often involve deploying networks within the city, allowing for more efficient management and comprehensive reporting of control systems through Big data analysis. Real-time and accurate reports generated from this Big data framework enhance the decision-making process. However, it is essential for the public to understand that participation in smart cities is not mandatory and there is more to it than meets the eye.

LITERATURE REVIEW

Imagine returning home in the evening and your house springs to life, all thanks to the advancements in sensor technology. Smart homes, also known as automated homes, intelligent buildings, integrated home systems, or domestics, are the result of recent design developments. In cryptography, both symmetric and asymmetric key encoding are used. Symmetric key encoding requires the same key for encryption and decryption, while asymmetric key encoding uses a pair of keys, a public key, and a private key, for encryption and decryption. The objective of cryptography is to ensure secure transmission of messages from the source to the destination without interception. By networking individual system modules, preset scenes can be executed to make your everyday life safe and comfortable. Imagine arriving at your house, and the garage door opens, the driveway is well lit, blinds are raised, and the alarm system is deactivated. When you leave your house, this technology ensures that your lights are switched off, blinds are lowered, lobbies are at rest, heating is turned down, and the alarm system is activated with a simple touch of a button. The door communication station at the entrance is robust, weather-resistant, and features solid metal buttons and illuminated glass nameplates. It is highly secure against tampering and can only be dismantled using a special tool. Depending on the system configuration, when the bell button is pressed in the dark, exterior lighting is automatically switched on to welcome visitors.

Optimum communication and safety are always guaranteed. The hidden camera captures sharp images, and the digital signal processor ensures excellent speech quality. The high-quality TFT color monitor inside the house displays the transmitted image, which can be shifted or zoomed in on via the onscreen display with touch functionality. The proposed system does not require a dedicated server PC and offers a novel communication protocol to monitor and control the home environment beyond basic switching functionality. With integrated full duplex operation and a digital signal processor, the system enables error-free and synchronous speech, telephone calls, and automatic calibration to ambient conditions. Active suppression of street noise optimizes comprehensibility. The indoor station has audio and video functions, and its touch screen and large push button guarantee simple and convenient adjustment and operation. Individual messages can be recorded and saved with the voice memo function, and when a message is left, an LED on the keypad flashes to indicate its presence.

When the doorbell is pressed, the camera image is automatically stored with the date and time, allowing you to determine who was at the door while you were away. The menu can be accessed by touching the info button, and stored messages are displayed chronologically. You can select or retrieve picture messages using the arrow keys. IoT technology welcomes you into the house by raising the internal blinds and switching on ceiling lights. Various scenes can be programmed using a central controller. With a presence detector, you can control room lighting, saving energy by only switching on lights when someone is present. LED pilot lights illuminate the stairs, ensuring safety even when the ceiling lights are off. The room controller sets the right mood, whether for a game of chess or a cozy evening by the fire, with just a click of a button. LED outlets help navigate through dark rooms without the need to switch on the lights. The kitchen diner, as the focal point of the house, is ideally suited for the IoT home controller. Its user-friendly touch screen allows for management of functions throughout the house.

Enabling IoT and Big data

Controlling and visualizing the central functions of your house is effortless with individually installed control panels in each room. Additionally, the intelligent facility pilot software allows control via any PC, thanks to its bundle of Windows application standard interfaces. This multi-room control enables you to listen to news in the kitchen, rock music in the bathroom, and a radio play in the children's bedroom. Smart metering is a crucial aspect of intelligent and efficient energy management. With the facility pilot, it is logical to continuously record, display, and evaluate consumption values for electricity, water, and thermal energy. This feature provides an overview of your house's security status, indicating whether any doors or windows have been opened. Network cameras are visualized, allowing you to monitor activities inside and around your house.As primary energy costs rise, sophisticated heating control systems become more important. The facility pilot simplifies this task by allowing you to adjust the thermal settings in each room based on demand and occupancy. The visualization screen displays set points and actual temperatures in all rooms, providing easy control and influence. Blinds, shutters, and curtains also contribute to heat protection by shielding against solar radiation in summer and reducing heat transmission in winter. Automatic time and weather-dependent control are highly recommended.

Lighting control through the facility pilot offers increased convenience and energy savings. In addition to switching and dimming lights from one location, the software enables the creation of individual scenarios by combining multiple light fittings and blinds in a specific area. A roof-mounted combo sensor provides weather data, which is connected to the weather statin through the facility pilot. The facility pilot can even display internet content using its browser function when connected to a network with internet access via its LAN interface. Whether simple browsing or complete remote interrogation of your building functions, the facility pilot offers a wide range of capabilities. An energy-saving automatic switch ensures that lights are turned on when someone is present. To enhance the landscape, treated water will be filtered by grass, allowing its reuse throughout the city. Nutrient uptake from the grass will contribute to the beauty of the landscape. Special trees, such as date palms, will be planted in the smart city, serving both aesthetic and functional purposes. For example, date palms need to be pollinated in the spring, and the dates can be harvested in August. Other trees like avocado, papaya, pomegranates, mulberry, and fig trees will benefit from the shade provided by the palm trees. Irrigation and treatment systems will be installed using pipes across the city, utilizing treated sewage for watering these plants.

Smart City Energy Management

The smart grid revolutionizes the way electricity and information are exchanged between utilities and customers. It is an evolving network of communications, controls, computers, automation, and innovative technologies working together to enhance the efficiency, reliability, security, and sustainability of the grid. With the integration of newer technologies like wind and solar energy production and plug-in electric vehicle charging, this smart grid replaces aging infrastructure and enables utilities to effectively communicate with consumers to manage their electricity needs.The smart home plays a crucial role in this system, allowing consumers to actively manage their electricity usage. Through smart meters, which measure a home's electricity consumption more frequently, utilities can provide customers with accurate information to effectively manage their electricity bills. Inside the smart home, a home area network (HAN) connects smart appliances, thermostats, and other electric devices to an energy management system. Smart appliances and devices can adjust their operation schedule to reduce electricity demand on the grid during critical times, leading to lower energy bills for consumers. These devices can be controlled and scheduled remotely over the web or through other interfaces like a TV.

Analyzing different scenarios helps evaluate the impact of uncertainties related to renewable energy sources on the optimal planning solution. While renewable resources like wind and solar power are sustainable and growing sources of electricity, their variable nature adds complexity to grid operations. The smart grid provides the necessary data and automation to efficiently integrate solar panels and wind farms into the grid, optimizing their energy production and utilization. To meet the constantly changing energy demands, utilities must manage power plant operations based on the required power at different times of the day. The cost of delivering power varies depending on the time of day it is consumed. Peak demand times, when electricity usage is high, require additional and often

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less efficient power plants to be activated, resulting in higher delivery costs. By actively moderating electricity usage, especially during peak demand times, utilities can reduce operating costs. Through the smart grid, utilities can incentivize consumers to shift their electricity usage away from peak hours, leading to a more evenly distributed electricity production throughout the day.

Deployment of grids in smart cities

India is poised to enter a new era of growth and technological advancement, but the increasing energy demand poses a significant challenge. It is projected that India's energy demand will triple in the next decade, requiring efficient and sustainable solutions. Smart grids offer a way to meet this growing demand for electricity while enhancing the efficiency of power transmission and distribution networks. The Ministry of Power, Government of India, has assigned smart grid pilot projects to state-owned distribution utilities. The New Energy Technology Development Organization (NEDO), an agency of the Government of Japan, has offered to fund the Smart Grid project in India through a Japanese government grant. NEDO has partnered with a consortium led by Fuji Electric Japan to implement this project, leveraging the strong cross-cultural and business relationship between India and Japan. Fuji Electric is at the forefront of developing new energy technologies in India. Smart grids leverage digital technology to create greener and more efficient energy transmission and distribution systems. Fuji Electric Japan and Fuji Electric India are working together to implement the smart grid project in an Indian state.

 Consistent and reliable power quality is crucial for business success. India faces frequent power fluctuations and inconsistent supply, hindering the productivity of businesses. Machines equipped with sensitive electronic components suffer damage and malfunctions due to voltage fluctuations. Stable power supply would extend the lifespan of machines, eliminating the need for large servos and constant voltage transformers. Furthermore, a continuous and reliable electricity supply would reduce transmission and distribution losses, which currently stand at a high 30% in the country. Strengthening the electrical network and improving resource management are essential to address these issues. Smart grid technology can seamlessly integrate into the existing electrical grid infrastructure. Any faults or issues along the power transmission line would be instantly reported to the grid, allowing for prompt repairs. With a smart grid, the power supplied to consumers would have uniform quality, without voltage fluctuations. Additionally, as energy consumption predominantly occurs in cities, which are hubs of economic activity, implementing smart grid solutions in urban areas would be particularly impactful.

Transcending the Era of Smart Homes

The future of urban transportation is being reshaped by advancements in technology, including autonomous cars, buses, and on-demand shuttles. These connected vehicles hold the potential to solve major transportation challenges in urban areas. The Smart City challenge in India encourages midsized cities to apply for resources and leverage technology to address transportation issues. The winning city will have the opportunity to implement bold, data-driven ideas that make transportation safer, easier, and more reliable.The convergence of technology and transportation offers tremendous opportunities for communities, but local decision-makers need to envision how these tools can enhance mobility, reduce climate change impacts, improve livability, and enhance safety. The Smart City challenge aims to stimulate conversations and encourage innovative solutions across India. Technologies that help prevent collisions are being developed and can be applied to urban environments where pedestrians, cyclists, and vulnerable road users coexist. By collecting data on near-collisions and analyzing patterns, infrastructure planners can make informed decisions to reduce future accidents.

Cities serve as living laboratories for testing new capabilities to solve problems. However, cities often lack sufficient resources to implement large-scale initiatives. International companies work with cities on pilot projects, including in Indian states. While there is global interest in future smart city solutions, implementation depends on funding and finding the right business models. For instance, upgrading street lamps to energy-efficient LEDs presents an opportunity to add additional sensors that can detect human presence or monitor traffic flow. However, determining who pays for these upgrades and defining sustainable business models remain challenges. The connectivity of everything is a fundamental aspect of smart cities. However, network infrastructure ownership and provision

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become public policy issues. Cities need to establish decision-making offices and address spectrum challenges. Municipalities that lead in these areas can become exporters of solutions. Connectivity is crucial for running a city efficiently, and when everything is connected, bandwidth demand increases significantly. Ensuring open and accessible urban data for all stakeholders is a complex problem that requires coordination. As cities undergo modernization, it is essential to prioritize connectivity in infrastructure, such as lamp-posts and streetlights. Access to data and connectivity should be universal, enabling effective use of urban data to drive informed decision-making.

RESULTS AND DISCUSSION

The aim is to establish a theory that latest advancements like IoT, Cloud and Big data can be used as a bedrock for sustainable smart cities in India. In this chapter we would like to demonstrate the use of IoT, Cloud and Bigdata using a prototype model for future smart cities in India. For the said purpose we have divided our research work into three phases among which we will discuss Phase-I and Phase-II in this chapter and Phase-III in the Results chapter . Figure 1 above illustrates several crucial aspects of the infrastructure that will be incorporated into future smart cities in India, as envisioned through our research. The following are explanations for the buildings included in the layout: EDM Centre: EDM, or Electronic Data Management Centre, serves as a centralized hub for data acquisition from various sources across the city. This facility plays a vital role in a smart city scenario. With the presence of IoT-based sensors throughout the city, there is a significant influx of sensory data related to monitoring, retail market transactions, banking, and network transactions, among others. The primary purpose of the EDM Centre is to properly store, filter, and analyze this vast amount of data. Staff members at this centre are responsible for maintaining city records, issuing certificates, and providing services to stakeholders. Essentially, the EDM Centre functions not only as a municipal corporation hub but also as a mega data centre equipped with advanced equipment and sophisticated software for analysis and reporting. The idea is to utilize Big Data technology in this centre, ensuring its integration with the IoT network spread across the city. Establishing an EDM Centre is essential in a smart city to ensure efficient data management, as a lack of streamlined data management systems could lead to chaos in such an advanced urban environment. Connecting the EDM Centre with the city's infrastructure enables continuous monitoring and contributes to the overall sustainability of the smart city vision.
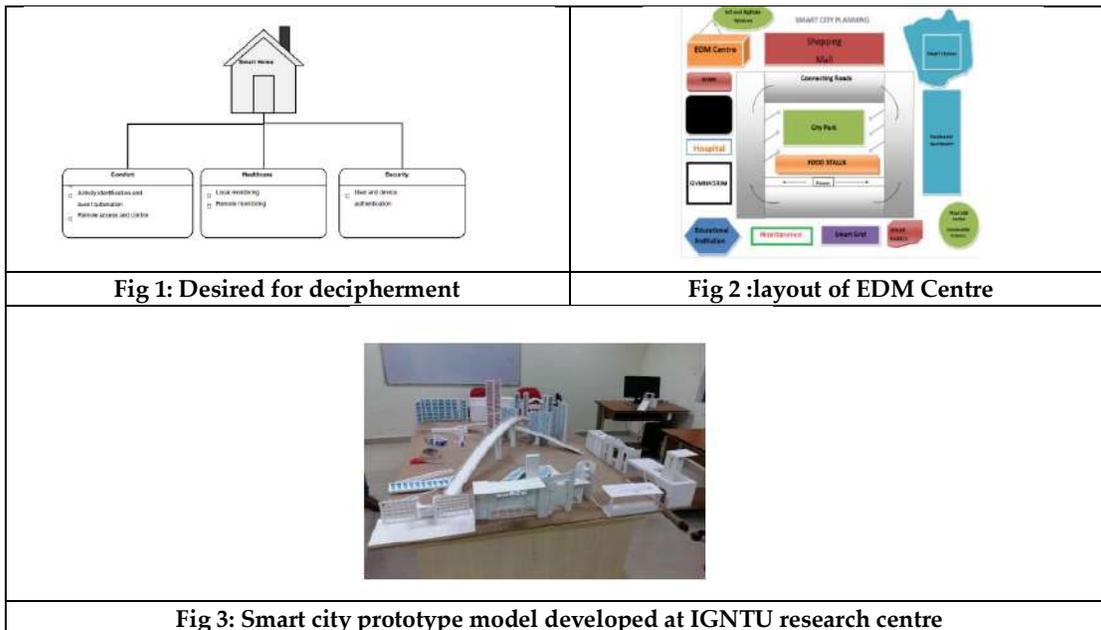
CONCLUSION

Our goal is to establish sustainable smart cities in India by leveraging technologies like IoT, Big Data, and Cloud computing. We recognize that data is a crucial resource for achieving sustainability and propelling us into the future. Cities worldwide are progressively integrating technology into every aspect of their operations, including public transportation, IT connectivity, water and power supply, sanitation, solid waste management, urban mobility, governance, and citizen participation. This integration utilizes various cutting-edge technologies, from Big Data to the Internet of Things. By the year 2050, it is estimated that 70% of the global population will be residing in cities, occupying less than 2% of the Earth's surface. This rapid urbanization presents numerous challenges, including pollution, infrastructure, accessibility, traffic congestion, mobility, safety, and public health, to name a few. The development and integration of innovative technologies such as the Internet of Things and Artificial Intelligence offer multifaceted solutions, which are known as smart cities today. Smart cities are highly interconnected urban areas equipped with advanced technologies to enhance the lives of their residents. In India, there are still neighbourhoods struggling with limited access to electricity. In a smart city, sensors would be deployed to analyze electricity usage across various sectors, allowing for optimized energy distribution throughout the power grid. This would result in fewer power outages and a more balanced energy distribution system.

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Fig 1: Desired for decipherment	Fig 2 :layout of EDM Centre

Fig 3: Smart city prototype model developed at IGNTU research centre

RESEARCH ARTICLE

A New Series of Schiff's Base Metal Complexes and Their Antibacterial and DNA Photo Cleavage Activity of Dehydroacetic Acid Analogue

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ABSTRACT

The development of a series of new Schiff base metal complexes of Cobalt(II), Manganese(II), Nickel(II), Copper(II), and Zinc(II) with a tridentate (three donor atoms) Schiff base was the outcome of the interaction between propionic acid hydrazide and Dehydroacetic acid analogue. The synthesized ligand and metal complexes were characterized by mass spectrometry, ^{1}H and ^{13}C NMR, IR (infrared) spectroscopy and elemental analysis. According to the IR spectrum data, during formation of complex coordinate bond between enolic O and azomethine N atoms with metal ions and the ligand behaves as a tridentate ligand with ONO donor atoms. The evolution of metal ligand bonding in a 1:1 stoichiometric ratio is shown by the complexes' mass spectra (M:L). All synthesized complexes were examined for their ability to combat with both gram-positive and gram-negative bacteria using *Gentamycin* as a reference drug. The ligand and metal complexes also screened for their DNA-Photocleavage activity using gel electrophoresis method. In contrast to ligands, metal complexes have been found to reflect higher activity and future improvements to ligand structure may result in more potent antibacterial and anti cancer medications.

Keywords: DHA (Dehydro acetic acid analogue), Tridentate Schiff base, Antibacterial properties, Spectroscopy.

INTRODUCTION

A significant function in medicinal chemistry is played by Schiff's base and their metal complexes. The Schiff's bases are a new family of crucial chemicals for medicine and pharmacology [1-6] that include double bonds between carbon and nitrogen. Schiff's bases are well known for being that are anti-fungal[7], anti-bacterial[8-11], anti-tuberculosis[12], anti-anthelmintic[13], andanti-tumor[14-15] DNA binding[16] and cleaving agents[17-19] due to the chelating activity of the azomethine nitrogen atom. Schiff's bases were widely used in analytical chemistry for the catalyst in various organic reactions like polymerization and hydrogenation as well as the identification of harmful metals in low concentrations [20] in the purification of the untreated wastewater from industries [21]. Many heterocyclic derivatives with powerful anti-fungal and anti-microbial [22-23] capabilities have been created using dehydroacetic acid, a flexible starting material. Numerous DHA-based Schiff bases and their metal complexes with various metal ions have already been created and tested for anti-fungal, in vitro antibacterial and DNA photo cleavage activities [24-25] because of the promising anti-microbial and chelating capabilities of DHA.

In addition to this, DNA is the principal site of action for the majority of anticancer medicines, according to cell biology studies. The DNA of cancer cells can interact with tiny molecules to stop cell division, which may result in cancer cells dying [26]. In recent years, the relationship between metal ions and DNA has become more significant in a desire to look for new and potentially effective non-radioactive chemotherapeutic treatments [27] Numerous Schiff's bases were discovered to have anticancer qualities. Design and manufacture of such metal complexes that can precisely bond with tumor cell DNA molecules are essential because they can reflect important host structure information and potentially function as anti-tumor drugs in the future. For these goals, the field of transition-metal complexes has been thoroughly investigated. The way and molecule-DNA binding affinity of such complexes determines how effective they are, though, in the host cell. . In the current study, we report the synthesis of a novel hydrazone Schiff base via a condensation reaction of propanoic acid hydrazide with dehydroacetic acid analouge and further report the preparation of its complexes with first transition metal ions. The ligand and all of the metal complexes were studied using a variety of analytical methods, including ^{1}H, ^{13}C NMR, IR, mass spectrometry, and elemental analysis conductance. For DNA photo cleavage study, Schiff's and its metal complexes were finally screened.

MATERIALS AND METHODS

Merck's DHA was acquired and used without additional purification. All additional chemicals including solvents was of LR grade and were used exactly as they were provided. In this study, double distilled water was used. Using a Bruker 500 MHz instrument, the ^{1}H and ^{13}C NMR of the ligand and complexes were recorded, respectively. IR spectra were obtained using the KBr pellet method on a Simadzu IR Affinity in the 4,000–400cm-1 range. The Agilent (ALR-QC-LCMS) Mass Spectrometer was used to collect mass spectra.

EXPERIMENTAL SECTION
Synthesis of Dehydroacetic acid analogue
1. Add4-hydroxy-6-methyl-2-pyrone(1.26g,.99mmol),propionyl chloride(.960ml,11.0mmol),NEt$_3$(1.68ml,11.9mmol),DMAP(13mg,.10mmol)and toluene(50ml)to a100ml round bottom flask equipped with a reflux condenser.
2. Stir the mixture under Argon.
3. Heat the mixture to reflux for 72 hrs.
4. Concentrate the mixture by flash chromatography (4:1 hexanes/EtOAcOH with 1% AcOH) to obtain the product.

Characterization of analouge

^{1}HNMR (DMSO-d_6, 500 MHz) (ppm): 2.38(S,3H,CH3) ;4.66(S,1H,Ring proton);2.75(m,2H,CH2);1.31(t,3H,CH3); 6.13(S,1H,OH) The appearance of extra CH_2 at 2.75 (m,2H,CH2) confirms formation of analogue.

Synthesis of Ligand

In accordance with the steps outlined below, the ligand was created by reacting Acetic hydrazide (0.01 mol) with DHA analogue (0.01 mol). propionic hydrazide (0.01 mol) was dissolved in 25 ml of aqueous ethanolic solution while being constantly stirred, and 25 ml of a warm ethanolic mixture containing (0.01 mol) DHA was then added After being refluxed for an hour in the water bath, the reaction mixture was then allowed to cool at room temperature. The end result underwent filtering, two washes with 70% aqueous ethanolic solution, and four hours of drying in a hot air oven at 65 °C. The resulting solid has no colour.

Characterization of ligand

Color: Colour less.

Yield: 81%,

M.P.: 216°C

IR(KBr,cm^{-1}): 3,468(w),m(OH);1,653(s),m(C=N); 1,683(s), m(C=O); 1,151(s), m(C–O).

^{1}H NMR (DMSO-d_6, 500 MHz) (ppm): 1.807 (s, 3H, CH_3); 0.772 (m,3H, N=C -CH_2-CH_3); 1.524 (m,2H, N=C–CH_2); 1.359 (m,3H, O=C-CH_2-CH_3); 1.981 (m,2H, O=C-CH_2); 6.141 (s,1H, ring proton); 7.241 (s,1H, CONH); 10.67 (s,1H, enolic). **^{13}C NMR** (DMSO-d_6,100 MHz) (ppm): 23.33 (C-1); 170.03 (C-2); 105.11 (C-3); 183.06 (C-4); 83.22 (C-5); 182.66 (C-6); 155.11 (C-7); 19.55 (C-8); 10.11 (C-9);1160.17 (C-10); 30.03 (C-11); 13.91 (C-13)

MS: m/z[M:1] 252.12 Anal.Calcd.for$C_{10}H_{12}N_2O_4$: Carbon(C) 57.16,Hydrogen(H) 6.36, Nitrogen(N) 11.10, Oxygen(O) 25.37.

SYNTHESIS OF METAL COMPLEXES
GENERAL PROCEDURE

By combining a 25 ml methanolic solution of the ligand (PL^1) with a 10 mL methanolic solution of the corresponding metal salt, several metal compounds were created. The pH of the resulting reaction mixture was adjusted to eight with the addition of a 10% methanolic KOH solution. The solution was then allowed to cool at Room Temperature after four hours of refluxing. The complexes were filtered, washed with excess ethanol to remove unneeded metal salts, then dried for six hours at 70°C in a hot air oven, and the compounds were found to be non-hygroscopic at room temperature.

COMPLEX 1

[($C_{14}H_{18}N_2O_6$*)Mn] PL^1(Mn)*

Color: Orange

Yield:77%

M.P:283°C.

IR(KBr,cm^{-1}) 3,466(w), m(OH); 1,683(s), m(C=N); 1,588(s),m(C=O);1,288(s),m(C–O);491(s),m(M–N);642(s),m(M–O).**^{1}NMR**(DMSO-d_6), 500 MHz) (ppm): 1.89 (s, 3H, CH_3); 1.38 (t,3H,-N=C-CH_2–CH_3); 1.90 (s, 3H, -$COCH_3$); 1.52 (m, 1H,-N=C-CH_2); 6.09 (s,1H, ring proton); 8.38 (s, 1H, CONH); 2.31 (m, 2H, O=C- CH_2); 1.41 (t, 3H, O=C-CH_2-CH_3). **MS**: m/z[M:1] 366.2 Anal. Calcd. for $C_{14}H_{19}N_2O_5Mn$: Carbon(C) 44.01; Hydrogen(H) 5.47; Nitrogen(N) 08.00; Oxygen(O) 22.84; Manganese(Mn) 15.69.

COMPLEX 2

[($C_{14}H_{19}N_2O_5$*)Zn] PL^1(Zn)*

Color: Colourless

Yield:81%

M.P:281°C.

IR(KBr,cm^{-1}) 3,468(w), m(OH); 1,623(s), m(C=N); 1,588(s),m(C=O);1,288(s),m(C–O);491(s),m(M–N);642(s),m(M–O). **^{1}NMR**(DMSO-d$_6$), 500 MHz) (ppm): 1.86 (s, 3H, CH$_3$); 0.77 (t,3H,-N=C-CH$_2$–CH$_3$); 1.89 (s, 3H, -COCH$_3$); 1.77 (m, 1H,-N=C-CH$_2$); 6.16(s,1H, ring proton); 8.14 (s, 1H, CONH); 2.32 (m, 2H, O=C- CH$_2$); 1.35 (t, 3H, O=C- CH$_2$-CH$_3$). **MS**:   *m/z*[M:1] 360.60 Anal. Calcd. for C$_{14}$H$_{19}$N$_2$O$_5$Mn: Carbon(C) 46.62; Hydrogen(H) 5.31; Nitrogen(N) 07.77; Oxygen(O) 22.18; Manganese(Zn) 18.13.

COMPLEX 3
[(C$_{14}$H$_{19}$N$_2$O$_5$*)Ni] PL^1(Ni)*
Color: Green
Yield:78%
M.P:287°C.
IR(KBr,cm^{-1}) 3,466(w), m(OH); 1,623(s), m(C=N); 1,575(s),m(C=O);1,366(s),m(C–O);491(s),m(M–N);642(s),m(M–O). **^{1}NMR**(DMSO-d$_6$), 500 MHz) (ppm): 1.97(s, 3H, CH$_3$); 1.35 (t,3H,-N=C-CH$_2$–CH$_3$); 1.98 (s, 3H, -COCH$_3$); 1.53 (m, 1H,-N=C-CH$_2$); 6.34 (s,1H, ring proton); 8.24 (s, 1H, CONH); 2.22 (m, 2H, O=C- CH$_2$); 1.38 (t, 3H, O=C- CH$_2$-CH$_3$).**MS**:   *m/z*[M:1] 354 Anal. Calcd. for C$_{14}$H$_{19}$N$_2$O$_5$Ni: Carbon(C) 47.50; Hydrogen(H) 5.41; Nitrogen(N) 07.91; Oxygen(O) 22.60; Manganese(Zn) 16.58.

COMPLEX 4
[(C$_{14}$H$_{19}$N$_2$O$_5$*)Cu] PL^1(Cu)*
Color: Colorless
Yield:78%
M.P:281°C.
IR(KBr,cm^{-1}) 3,443(w), m(OH); 1,617(s), m(C=N); 1,585(s),m(C=O);1,274(s),m(C–O);491(s),m(M–N);642(s),m(M–O). **^{1}NMR**(DMSO-d$_6$), 500 MHz) (ppm): 1.88(s, 3H, CH$_3$); 0.77 (t,3H,-N=C-CH$_2$–CH$_3$); 1.98 (s, 3H, -COCH$_3$); 1.52 (m, 1H,-N=C-CH$_2$); 6.19 (s,1H, ring proton); 8.18 (s, 1H, CONH); 2.31 (m, 2H, O=C- CH$_2$); 1.35 (t, 3H, O=C- CH$_2$-CH$_3$).**MS**:   *m/z*[M:1] 358.86 Anal. Calcd. for C$_{14}$H$_{19}$N$_2$O$_5$Cu: Carbon(C) 46.86; Hydrogen(H) 5.34; Nitrogen(N) 07.81; Oxygen(O) 22.29; Manganese(Zn) 17.71.

COMPLEX 5
[(C$_{14}$H$_{19}$N$_2$O$_5$*)Co] PL^1(Co)*
Color: Colorless
Yield:77.5%
M.P:293°C.
IR(KBr,cm^{-1}) 3,330(w), m(OH); 1,658(s), m(C=N); 1,614(s),m(C=O);1,240(s),m(C–O);491(s),m(M–N); 642(s),m(M–O). **^{1}NMR**(DMSO-d$_6$), 500 MHz) (ppm): 1.86(s, 3H, CH$_3$); 1.52 (t,3H,-N=C-CH$_2$–CH$_3$); 1.90 (s, 3H, -COCH$_3$); 1.52 (m, 1H,-N=C-CH$_2$); 6.09 (s,1H, ring proton); 8.31 (s, 1H, CONH); 2.10 (m, 2H, O=C- CH$_2$); 1.38 (t, 3H, O=C- CH$_2$-CH$_3$).**MS**:   *m/z*[M:1] 354 Anal. Calcd. for C$_{14}$H$_{19}$N$_2$O$_5$Ni: Carbon(C) 47.47; Hydrogen(H) 5.41; Nitrogen(N) 07.91; Oxygen(O) 22.58; Manganese(Zn) 16.64.

RESULT AND DISCUSSION

Chemistry

DHA and its derivatives have a significant amount of chemical and physical relevance, according to the conducted research in literature. The chemistry and biology of DHA and its derivatives were thoroughly investigated by R.P. Saini and Sushil Kumar from our research lab. As a result of their groundbreaking research, it is anticipated that metal complexes of the Dehydroacetic Acid Analogue may have increased biological activity. We started our research from the synthesis of a chemical analogue of DHA namely (4-hydroxy-6-methyl-2-pyrone) reported in literature. It involves treatment of DHA with propionyl chloride in presence of Triethyl amine and toluene as solvent along with DMAP as catalyst. Mixture was stirred under Argon atmosphere for an hour than resultant was

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transferred to round bottom flask and refluxed for 72 hrs. The product obtained was concentrated by using flash chromatography and desired compound was obtained. The spectroscopic techniques like mass, ^{1}H NMR and ^{13}C NMR were used to identify the structure of synthesized analogue. The strong peak at 4.66 ppm is caused by the ring proton; the multiplet at 2.75 ppm is caused by 2H of CH_2 . The appearance of extra CH_2 at 2.75 ppm CH_2 confirms formation of analogue. The singlet at 2.38 ppm is caused by CH3 attached to the ring and the triplet at 1.31 ppm is caused by CH_3 next to CH_2 and the singlet at 6.13 ppm in enolic OH. The method used to produce the ligand from the analogue of DHA involved dissolving propionic hydrazide (0.01 mol) in an aqueous ethanolic solution while stirring continuously, then adding heated ethanolic mixture containing the analogue of DHA (0.01 mol). The reaction mixture was allowed to cool at room temperature and cleaned with ethanolic solution after being refluxed for an hour in the water bath., The resulting solid has no colour and was characterized by its ^{1}H NMR,^{13}C NMR and Mass spectroscopy. The ^{1}H NMR spectrum of the ligand showed a intense peak of 3 methyl protons of DHA molecule as a singlet at delta value 1.807. The 3 methyl protons of (CH_2-CH_3) observed as an adjacent multiplet at 0.772 delta value. The singlet at 8.20 ppm is due to 1 H of -CHO while the singlet at 6.141ppm due to ring proton. The CONH proton resonated at 7.241 and the enolic proton of the DHA ring observed as a singlet at 10.67ppm.

Appearance of peak at 7.241ppm confirms formation of ligand. Similarly, **^{13}C NMR** (DMSO-d$_6$, 500 MHz) showed that the disappearance of carbonyl carbon of DHA analogue from 220 and appearance of an additional peak due to carbon of (-C=N) at 155.11 further confirms the synthesis of ligand. The 23.33 ppm due to CH_3 of DHA .The mass spectral analysis of the above compound showed M+1 peak at mass spectra peak at 252.12. The Ligand was dissolved in methanol and then a methanolic solution of metal acetate was added to this methanolic solution. The resultant reaction mixture was refluxed at 70 degrees Celsius for 3 to 4 hours. The resulting reaction mixture's pH was brought down to eight. The solid separated during the refluxing time, and the bulk was then allowed to cool at room temperature. Filtering and refrigerated methanol were used to wash the solid. The resulting solid underwent further recrystallization in ethanol before being baked at 70°C. The complete physical and chemical analysis of the above synthesized compounds was performed and was characterized by ^{1}H NMR, ^{13}C NMR, Mass and IR spectroscopy. In all complexes, values of NMR come approximately same and were in accordance with expected values. A triplet due to 3H of methyl proton of N=C-CH2-***CH3*** observed at delta 0.77 , multiplet due to 2 protons of -*N=C*-CH_2Observed at delta 1.52,singlet of methyl 3H attached with aromatic ring C6H5-CH3 observed at delta 1.86, singlet due to 3 protons attached with carbonyl group COCH3 observed at delta1.89,sharp singlet due to ring proton observed at delta 6.16,singelet due to one proton of CONH observed at delta 8.14,and triplet due to 3H of O=C-CH2-***CH3*** observed at 1.35 and multiplet due to -*N=C*-CH_2 observed at 1.53ppm.

Similarly, mass spectra of complex [($C_{10}H_{12}N_2O_6$)Mn] FL^1(Mn) gives peak at *337.02,*[($C_{10}H_{12}N_2O_6$)Zn] FL^1(Zn) give peak at *346,*[($C_{10}H_{12}N_2O_6$)Ni] FL^1(Ni) give peak at *340.02,*[($C_{10}H_{12}N_2O_6$)Cu] FL^1(Cu)give peak at 345.01,[($C_{10}H_{12}N_2O_6$)Co] FL^1(Co)give peak at 342.0 all values were found to be in accordance with expected values. In addition to this, the IR spectrum of the ligand illustrates the following characteristic bands at 3000–3500, 1653, 1683 and 1151cm^{-1}. These Bands may be assigned to t$_{OH}$ (intra-molecular hydrogen bonding), t$_{C=O}$(carbonyl group), t$_{C=N}$(azomethine) and t$_{C-O}$(enolic) stretching modes, respectively. In the spectra of metal complexes the absence of a weak broad band in the range 3,300–3,500cm^{-1}suggests the deprotonation of enolic –OH and subsequent coordination with the metal ion through the oxygen atom of the enolic group. It can further be supported by increase in frequency of enolic C–O stretch by some extent which is different in different complexes. In the IR spectra of metal complexes, the t$_{C=N}$ shifted to lower frequency as compared to free ligand which indicates the involvement of nitrogen atom of azomethine group in coordination with the metal ion. It may be due to the donation of lone pair of electrons of nitrogen atom of azomethine to the empty *d* orbitals, of metal ions. Furthermore, IR spectra of metal complexes show characteristic non-ligand bands in 570–650and440–501cm^{-1}regionwhich can be assigned to t$_{M-O}$ and t$_{M-N}$ vibrations, respectively.

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BIOLOGICAL ACTIVITY
Antibacterial activity

All synthesized complexes were examined for their ability to combat with both gram-positive and gram-negative bacteria using agar well diffusion method and findings thus obtained were compared with ***Gentamycin*** as a reference drug. The results were reported in the form of diameter of zone of inhibition at minimum inhibitory concentrations of 5mg/ml. As per the results obtained, it is clearly observed that all the metal complexes especially nicle complex showed good antibacterial activity against all the bacterial stains employed.

DNA Photo cleavage Activity

The gel electrophoresis method used to check the DNA photo cleavage activity of the synthesized ligand and metal complexes. Super coiled plasmid DNA used to complete the study. At the end of the study, it was observed that upon UV irradiation, ligand showed much less impact on the conversion of open circular DNA to the relaxed DNA when compared to its metal complexes. All the metal complexes showed excellent DNA photo cleavage activity than ligand itself. The results of study showed in Figure 2.

CONCLUSION

The synthesized ligand and its metal complexes showed good antibacterial as well as DNA photo cleavage activity. Some modifications in the structure of ligand may possess enhanced biological activity as conducted in this study. Even after the use of a huge amount of antibiotic drugs, Bacteria are becoming mutant day by day, so, there is a need of developing more potent antibacterial drugs in future to overcome this problem.

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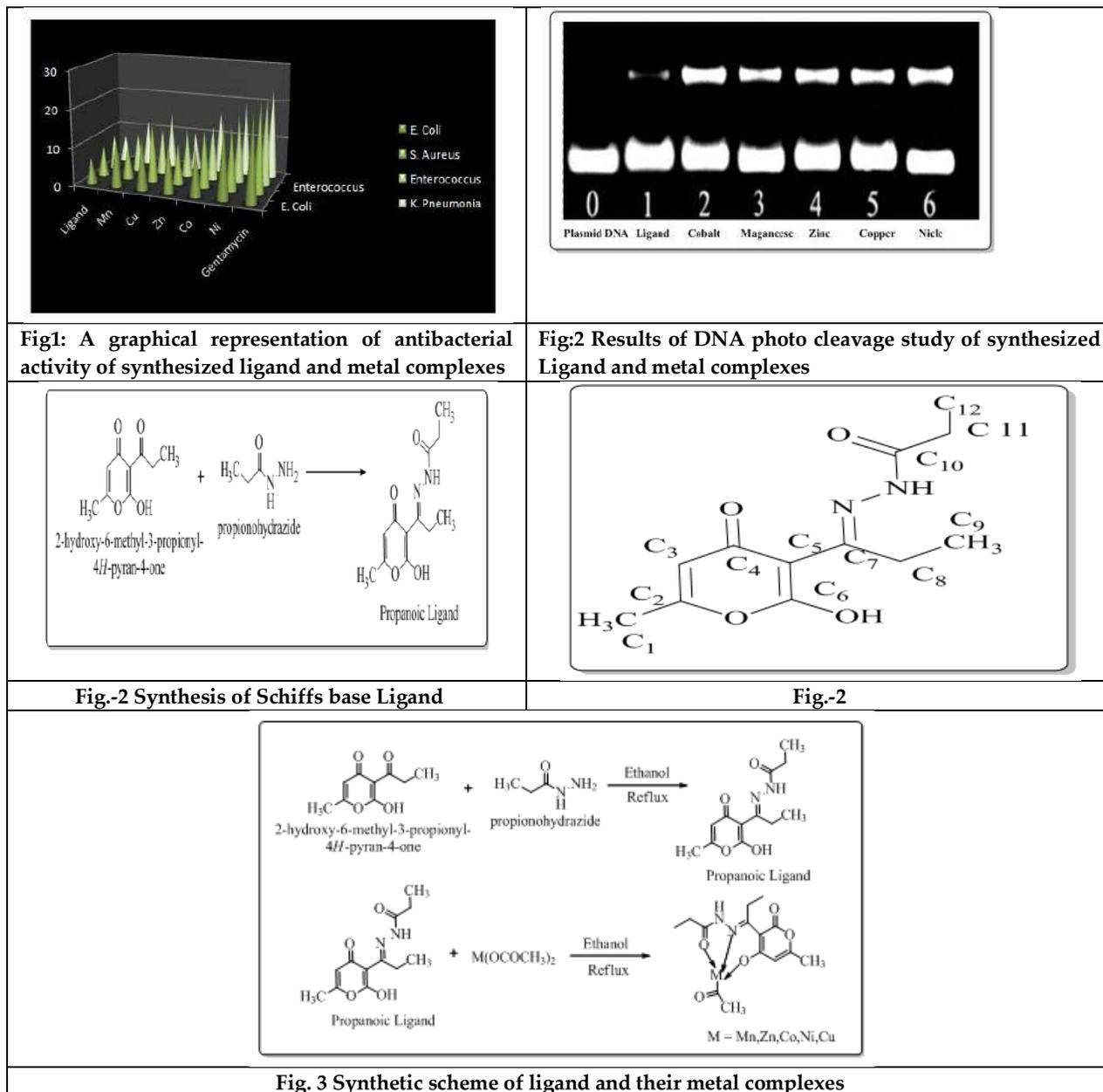
Table-1 Antibacterial activity of synthesized ligand and metal complexes with comparison to the reference drug *Gentamycin.*

Entry	E. Coli	S. Aureus	Enterococcus	K. Pneumonia
Ligand	7	8	9	7
Mn	12	10	10	12
Cu	14	152	12	15
Zn	12	11	13	10
Co	13	15	14	16
Ni	20	17	18	19
Gentamycin	23	24	23	23

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Fig1: A graphical representation of antibacterial activity of synthesized ligand and metal complexes	**Fig:2 Results of DNA photo cleavage study of synthesized Ligand and metal complexes**

Fig.-2 Synthesis of Schiffs base Ligand	**Fig.-2**

Fig. 3 Synthetic scheme of ligand and their metal complexes

RESEARCH ARTICLE

Evaluation of Anti-Inflammatory Activity Mono Ammonium Glycyrrhizinate in Rheumatoid Arthritis against Complete Freund's Adjuvant Induced Arthritis in Female *Albino wistar* Rats

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ABSTRACT

Mono Ammonium Glycyrrhizinate was used in the treatment of Rheumatoid Arthritis. The goal of the current investigation was to determine whether liquor rice root extract of Mono Ammonium Glycyrrhizinate has any potential to treat rheumatoid arthritis and to investigate its likely mode of action. Complete In order to evaluate the Rheumatoid Arthritis activity of liquor rice root extract fractions at 50 mg/kg and 100 mg/kg oral doses for 28 days, female *Albino wistar* rats were administered Freund's adjuvant, which induces arthritis. The analysis included measurements of the ankle joints' radiographic and histological composition, paw volume, body weight, arthritic score, hematological and biochemical markers, and so forth. By using the Sandwich ELISA Method, pro-inflammatory cytokine arrays (IL-6, IL-1,) were calculated. Significant (p 0.05) reduction of arthritic score, paw volume, and thickness with liquor rice root extract. Reduction in body weight and changes to hemological markers have been stopped by liquor rice root extract. Significant architectural alterations were found in the joints of treated rats after radiographic and histological analysis. In the current study, higher levels of (IL-6, IL-1) were found in the CFA-control group, which was a substantial increase compared to levels in the rats in the normal group. Comparing the rats treated with MAG at 50 and 100 mg/kg to the animals in the CAF-Control group, a Significant reduction in (IL-6, IL-1) levels was seen.

According to the available information, Mono Ammonium Glycyrrhizinate's protective effects against CFA-induced arthritis may have resulted from its improved haematological profile, antioxidant properties, and anti-inflammatory properties.

Keywords: Anti-inflammatory activity, mono Ammonium Glycyrrhizinate, Rheumatoid Arthritis, Complete Freund's adjuvant, Arthritis in Female *Albino wistar* Rats

INTRODUCTION

Rheumatoid arthritis (RA) is an auto-immune disease that is complex, multi factorial, and systemic in nature. It primarily affects the small joints in the hand and feet in the body [1]. It develops in a symmetrical manner and causes pain, stiffness, and impaired function. However, the pathogenesis of RA is the accumulation of microbial products in synovial tissue, as well as persistent infection of the articular surface of the joint, which triggers an immune response and changes the integrity of the joint components. In RA [2], the immune system responds to auto-refractory B-lymphocytes and produces rheumatoid factors (RF) auto-antibodies, as well as anti-cyclic Citrullinated Peptide (CP) antibodies. However, there are two sides to the immune response. Chronic inflammation plays an important role in the progression of disease and contributes to the development of age related diseases, including RA [3]. Liquorice is an herbaceous perennial plant that is native to southern Europe and Asia. It is related to beam and peas [4]. It grows to 1 meter high and has pinnate leaves that are 7-15 cm in length and 9-7 cm in length. The flowers are 0.8-12 cm in length, purple or pale whitish-blue in colour, and produced in loose inflorescences [5]. It is mainly found wild in the southern part of Europe and part of Asia. Today, it is cultivated in many parts of the world [6]. Liquorice can be used as a flavoring for tobacco, confectionery, beverages, jams and marmalades [7]. It is also used to treat many ailments and diseases. It is also known as an antiviral for slowing down the progression of HIV infection [8].

MATERIALS AND METHODS

Plant Material
Powdered roots of Mono Ammonium Glycyrrhizinate (Mesh size 250) supplied by Pharmaceutical Shop Jadavi Lallubhahi & Co. In Hyderabad, India [9]

Preparation of Plant Extract
The roots of liquor rice are weighed up to 40-50% and soaked with water. The roots are then macerated for 24 hours for softening. This softens the roots, making it easier to extract later. After the roots are macerated, the extract should be filtered and the resulting extract should be stored securely

Experimental Animals
In this study, adult female wistar rats weighing 200-210g were used. Animals were obtained from Mahaveer Enterprises in Hyderabad. Laboratory conditions were as follows: (1) 12:12 L/dark; (2) 23±10C; (3) Standard animal diet; (4) Ad libitum water; (5) CPCSEA approval of our collage for conducting animal experiments (Registration No: 516 / 01/ A/CPCSEA).

Experimental Design
Rats were acclimated for two weeks before the experiment. After acclimatization, rats were kept fasting for 18 hours before the experiment. Now, we have randomly split the rats into 4 groups of 6 animals.
Group I rats (normal control)
Group II rats (Disease control)
Group III rats (low dose test compound)
Group IV rats (high dose test compound)

Dose selection

The acute oral toxicity studies were performed in accordance with the OECD426 Guidelines. The studies were performed on female *albino wistar* rats weighing 25-35g. The study was divided into 4 groups of 6 rats each. The rats were fasted overnight. They were kept hydrated and fed libitum. The selected functional foods were orally administered at a dose of 2000 mg/kg body weight.

Evaluation of Rheumatoid Arthritis

Determination of Paw Volume

The Paw volume was measured with the help of a plethysis mograph. The results were recorded at 0th Day, 7th Day, 14th Day, 21st Day and 28th Day. Measurement of Adjuvant Arthritis The severity of Adjuvant arthritis was measured by measuring the hind paw volume. The increase of paw edema is calculated using the following formula [10].

$$\%\text{increase in paw Edema} = T_0\_T_t/T_0 \times 100$$

Where T_0 = Mean Paw Thickness at 0 and T_t = Mean Paw Thigh Thickness at a specific time. Results were statistically compared to CFA-Control.

Determination of Arthritic Score

The rats were evaluated for arthritis symptoms every three days from day 1 to 28 post-CFA using a scoring system designed to assess the severity of the condition. A 5-point scale was used to determine the severity of the erythroidism and the loci of the swelling, as well as the duration of the symptoms.

0 = no swelling or focal redness;

1= Finger joints with mild swelling;

2= Ankle or wrist joints with mild swelling.

3= Full-body inflammation;

4= Deformation or Alkalosis.

After treatment, the animals were dosed with anesthetics (inhalation of diethyl ether) and blood was drawn from Retro orbital sinus using EDTA-containing capillary tube for hematological and serum biochemical parameters (EDTA-free). Blood was left at room temperature for 30 minutes and then centrifuged for 10 minutes at 10:00 rpm. The biochemical parameters were as follows:

Determination of Hematological Parameters

On Day 28, following CFA-administration, blood samples were collected from all groups via cardiac puncture under mild general anesthesia with diethyl ether, and stored in appropriate blood collection tubes. [11] The hematological parameters (red blood cells, hemoglobin content, white blood cells, platelets) were assessed immediately after the blood sample collection with the help of biochemical auto analyzers.

X-Radiology Assessment

On the day 28 post CFA- injection, Radiographs were taken with X-Ray apparatus (PHILIPS Diagnose X-Ray, Amsterdam, and Netherlands). The focal film distance was 60cm at 55kVp and according to the extent of osteoporosis, joints spaces, soft tissue inflammation, sub chondral erosion, and joint ankylosis on a scale of 0-4 as described by vijaya Lakshmi etal. [12]The highest possible score is 20 per paw. X-Ray images were analyzed and separated by two certified radiologists who were blinded to the treatment groups.

Estimation of IL-6 by Sandwich ELSA Method

Materials to be provided by the End –User

To make a phosphate-based salt solution, add 8.0g of NaCl, 1.4g of Na_2HCO_4, 1.2g of HCl, 0.4g of KCL, and add 1L of deionized salt to 1L of water. The pH should be 7.4 and the filtration should be 0.2μm. You can also use a wash buffer, like Cat. Number 421601, or a PBS + 0.05% tween -20 solution. If you're looking for a stop solution, you can use Cat. Number 43001 or an acid solution like $2H_2SO_4$. Finally, you can use a plate sealer like Cat. Number 423601.

ELISA PROCEDURE
Day-1

For each well,add 100μL of dilute capture antibody solution, seal the well plate, and incubate for 24 hours at 20C to 80C.

Day-2

1. Wash Plate 4 Times*, block the plate by adding 200μL 1X Assay Diluent A to each well, seal plate and incubate at room temperature for1hour with shaking on a plate shaker. All the subsequent incubation with shaking should be 3.7 performed similarly.
2. Wash plate 4 times*, add μL diluted standards and samples to the appropriate wells.
3. Seal the plate and incubate at room temperature for 2 hours with shaking.
4. Wash plate 4 times*, add 100μL diluted detected antibody solution to each well, seal the plate and incubate at room temperature for 1hour with shaking.
5. Wash the plate 4 times*, add 100μL diluted Avidin-HRP solution to each well, seal the plate and incubate at room temperature for 30 minutes with shaking.
6. Wash plate 5 times*, soaking for 30 seconds to 1 minute per wash. Add 100μL of freshly mixed TMB substrate solution to each well and incubate in the dark for 15 minutes.[13]
7. Add 100μL of stop solution to each well. Read absorbance value at 450nm and 570nm within 15 minutes. [15]The absorbance at 570nm can be subtracted from the absorbance at 570nm can be subtracted from the absorbance at 450nm. Wash step is crucial to assay precision. Wash the plate with at least 300μL of wash buffer per well and bolt any residual buffer by firmly tapping the plate upside down or clean absorbent paper.

Estimation of IL-1βby Sandwich ELSA Method
Materials to be provided by the End –User& reagent preparation

Materials and reagent preparation of IL-1β are same as IL-6.

ELISA PROCEDURE
Day-1

Add 100μLdiluted capture antibody solution to each well, seal the plate and incubate overnight between 2^0C and 8^0C.

Day-2

1. Wash Plate 4 Times*, block the plate by adding 200 μL 1X Assay Diluent A to each well, seal plate and incubate at room temperature for1hour with shaking on a plate shaker. All the subsequent incubation with shaking should performed similarly.
2. Wash 4 times with wash buffer
3. Add 50 μL/well of assay buffer D to wells that contain either standard dilutions or samples.
4. Add 50 μL well of standard dilutions or samples to the appropriate wells.
5. Seal the plate and incubated at the room temperature for 2 hours with shaking.
6. Wash plate 4 times/ add100μL diluted detection antibody solution each well, seal the plate and incubate at the room temperature for 1 hour with shaking.[15]
7. Wash the plate 4 times add100μL diluted Avidin –HRP solution to each well, seal the plate and incubate at room temperature for 30 minutes with shaking.
8. Wash plate 5 times soaking for 30 seconds to 1 minute per wash. Add100μL of substrate solution to each well and incubate in dark for 20 minutes.
9. Add 100μL stop solution to each well. Read absorbance at 450nm and 570nm within 15 minutes. The absorbance at 570nm can be subtracted from the absorbance at 450nm.[16]

Plate washing: wash step is crucial to assay precision. Wash plate with at least 300μL of wash buffer and blot any residual buffer by firmly taping the plate upside down on clean absorbent paper.

Statistical Analysis

Following one-way ANOVA analysis, Dunnett's multiple comparison test is used to compare the results, which are presented as mean Standard deviation.

RESULTS

Safety Evaluation of Mono Ammonium Glycyrrhiziate (MAG)

During treatment, *Albino wistar* Rats' physiological function was compared to that of the healthy control group, which remained unaltered. Specifically, throughout the course of the study, there were no glaring abnormalities, toxic reactions, or deaths that occurred up to 28 days. The *albino wistar* rats in the treatment group do not gain or lose weight when compared to the control group, indicating the safety of the treatment.

Effect of MAG on CFA-Induced Arthritis in Paw Oedema

The paw swelling of the CFA Group Significantly Increased When Compared With the Control Group and Gradually Increased After the Model Manipulation, Indicates that the CFA Model Was Established Successfully. When compared to the CFA control group, the treated rats' paw swelling volume was significantly less after the administration of MAG (50 and 100mg/kg). The results below clearly demonstrate that the MAG has reduced RA paw swelling.

Estimation of Biological Parameters

All values were MEAN±SEM, n=6, ***$P<0.001$, **$P<0.04$, *$P<0.05$, and ns$P<0.05$.utilizing a one-way ANOVA-Dunnett's multiple comparison test and ###$p0.001$ when disease control was compared to the Control Group. All values were MEAN±SEM, n=6, ***$P<0.001$, **$P<0.04$, *$P<0.05$, and ns$P<0.05$.utilizing a one-way ANOVA Dunnett's multiple comparison test and ###$p0.001$ when disease control was compared to the Control Group All values were MEAN±SEM, n=6, ***$P<0.001$, **$P<0.04$, *$P<0.05$, and ns$P<0.05$.utilizing a one-way ANOVA-Dunnett's multiple comparison test and ###$p0.001$ when disease control was compared to the Control Group. All values were MEAN±SEM, n=6, ***$P<0.001$, **$P<0.04$, *$P<0.05$, and ns$P<0.05$.utilizing a one-way ANOVA-Dunnett's multiple comparison test and ###$p0.001$ when disease control was compared to the Control Group. All values were MEAN±SEM, n=6, ***$P<0.001$, **$P<0.04$, *$P<0.05$, and ns$P<0.05$.utilizing a one-way ANOVA-Dunnett's multiple comparison test and ###$p0.001$ when disease control was compared to the Control Group. All values were MEAN±SEM, n=6, ***$P<0.001$, **$P<0.04$, *$P<0.05$, and ns$P<0.05$.utilizing a one-way ANOVA-Dunnett's multiple comparison test and ###$p0.001$ when disease control was compared to the Control Group.

DISCUSSION

Rheumatoid arthritis (RA) is an abnormal autoimmune disease that damages the structure of the joints and causes deformity. Recently, CFA has gained popularity as a method for evaluating the effectiveness of herbal arthritis treatments. Liquorice root extract significantly (P 0.05) decreased paw volume, thickness, and arthritic score. Liquorice root extract has stopped changes in haematological parameters and weight loss. Significant architectural changes in the joints of treated rats were discovered through radiographic and histological analysis. When compared to levels in the rats in the normal group, the CFA-control group in the current study demonstrated elevated levels of (IL-6, IL-1), which was a significant increase. Significant reductions in (IL-6) and (IL-1) levels were seen in rats given MAG at 50 and 100 mg/kg

CONCLUSION

MAG shown to decrease the paw volume and increase the spontaneous activity in CFA induced RA in female wistar albino rats. The blood parameters like RBC, Haemoglobin counts were increased and decreased WBC by MAG at 100mg/kg has more potent activity while compared with 50mg/kg of MAG in CFA induced RA in female wistar albino rats. MAG at 50and 100mg/kg showed a significant reduction of IL-6, IL-1β levels in CFA induced arthritic in rats.(paw and sciatic nerve). Histopathological examination of paw revealed that the MAG treated rats showed significant regeneration of damaged paw of CFA induced arthritis in rats. The mono ammonium glycyrrhizinate showed protective activity in CFA induced arthritis might be due to their enhanced haematological profile, antioxidant and anti-inflammatory activity.

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Table -1Experimental design

Groups	Treatment
Group-1	Normal control (NC)
Group-2	Disease Control(DC)
Group-3	CFA + Low dose of Test compound
Group-4	CFA + High dose of Test compound

Table 2: Reagent Preparation

Reagent description	Dilute with	Dilution for 1 plate
Coating Buffer A (5X)	Deionized Water	2.4 ml in 9.6ml DIH_2O
Capture Antibody (200x)	1* Coating Buffer A	60μL in 12 ml buffer
Assay Diluents A(5X)	PBS	12ml in48 ml PBS
Detection Antibody (200x)	1*Assay Diluents A	60 μL in 12 ml buffer
Avidin-HRP(1,00x)	1*Assay Diluents A	12 μL in 12 ml buffer

Table 3 Effect of MAG on CFA-Induced arthritis in paw oedema

Groups	Paw Thickness(mm) (%Inhibition of Paw Oedema)			
	7th Day	14th Day	21th Day	28th Day
Control	0.44±0.05	0.44±0.05	0.45±0.05	0.45±0.05
Disease Control (CFA)	3.12±0.02 (15.75%)	3.4±0.03 (26.75%)	3.7±0.03 (37.80%)	3.9±0.02 (45%)
MAG (50mg/kg)	1.8 ±0.02 (16.3%)	1.5 ±0.05 (27.2%)	1.3 ±0.04 (15.75%)	1.17±0.04 (15.75%)
MAG (100mg/kg)	1.4±0.05 (31.5%)	1.06 ±0.4 (53.88%)	0.72 ±0.4 (66.31%)	0.60±0.05 (72%)

Table 4 Effect of MAG on Haemoglobin in CFA induced Rheumatoid arthritis in *albino wistar* **rats**

Groups	Haemoglobin						Mean ± SEM
	R1	R2	R3	R4	R5	R6	
Control	14.8	14.4	14.3	14.7	14.1	14.5	14.46 ± 0.10
Disease control (CFA)	7.5	9	7.9	8.2	10.2	10.8	8.93 ±0.54
MAG (50mg/kg)	12.11	12.13	12.7	12.5	12.14	12.16	12.29±0.10***
MAG (50mg/kg)	13.15	13.12	13.8	13.03	13.5	13.16	13.34 ± 0.12***

Table 5 Effect of MAG on RBC in CFA induced Rheumatoid arthritis in *albino wistar* rats

Groups	RBC COUNT (10^6/mcl)						Mean ± SEM
	R1	R2	R3	R4	R5	R6	
Control	6.8	7.56	6.2	7.5	9.7	8.75	7.75 ± 0.52
Disease control (CFA)	3.2	3.53	3.63	32.24	3.6	3.5	3.44 ±0.07###
MAG (50mg/kg)	4.5	4.3	4.1	4.2	4.35	4.3	4.29±0.05***
MAG (50mg/kg)	5.65	13.12	4.9	5.2	5.56	4.6	5.21 ± 0.16***

Table 6 Effect of MAG on WBC in CFA induced Rheumatoid arthritis in *albino wistar* rats

Groups	RBC COUNT (10^6/mcl)						Mean ± SEM
	R1	R2	R3	R4	R5	R6	
Control	3,300	3,100	2,500	2,700	3,500	3,500	3100 ± 171.2
Disease control (CFA)	8,500	7,800	9,000	7,700	8,200	9,500	8450 ±286.0###
MAG(50mg/kg)	4,300	4,200	4,250	4,250	4,550	3,000	4092±224.1ns
MAG(100mg/kg)	4,200	4,100	3,000	3,100	3,800	4,000	3700 ± 212.9***

Table 7 Effect of MAG on IL-6 of sciatic nerve in CFA induced Rheumatoid arthritis in *albino wistar* rats

Groups	IL-6 (pg/ml)						Mean ± SEM
	R1	R2	R3	R4	R5	R6	
Control	0.32	0.23	0.25	0.32	0.25	0.35	0.28 ± 0.02
Disease control (CFA)	0.778	0.879	0.98	0.78	0.945	0.756	0.85 ±0.03###
MAG(50mg/kg)	0.56	0.67	0.78	4.5	0.78	0.56	0.64±0.04**
MAG(100mg/kg)	0.42	0.52	0.53	0.41	0.54	0.45	0.47 ± 0.02***

Table 8 Effect of MAG on IL-6 of sciatic nerve and paw homogenate in CFA induced Rheumatoid arthritis in *albino wistar* rats

Groups	IL-6 (pg/mg of protein)	
	Sciatic nerve	paw
Control	0.28±0.02	0.32±0.02
Disease control (CFA)	0.85±0.03###	0.98±0.04###
MAG(50mg/kg)	0.64±0.04**	0.65±0.03*
MAG(100mg/kg)	0.47±0.02***	0.04±0.02***

Table 9 Effect of MAG on IL-1β of sciatic nerve in CFA induced Rheumatoid arthritis in *albino wistar* rats

Groups	IL-1β (pg/ml)						Mean ± SEM
	R1	R2	R3	R4	R5	R6	
Control	0.198	0.269	0.344	0.25	0.19	0.22	0.284± 0.02
Disease control (CFA)	0.954	0.798	0.884	0.725	0.988	1.009	0.856±0.04
MAG(50mg/kg)	0.624	0.538	0.624	0.523	0.788	0.79	0.64±0.04
MAG(100mg/kg)	0.414	0.403	0.356	0.42	0.354	0.59	0.472± 0.03

Table 10 Effect of MAG on IL-1β of sciatic nerve and paw in CFA induced Rheumatoid arthritis in *albino wistar* rats

Groups	IL-1β (pg/mg of protein)	
	Sciatic nerve	paw
Control	0.28±0.02	0.32±0.02
Disease control (CFA)	0.85±0.03###	0.98±0.04###
MAG(50mg/kg)	0.64±0.04**	0.65±0.03*
MAG(100mg/kg)	0.47±0.02***	0.04±0.02***
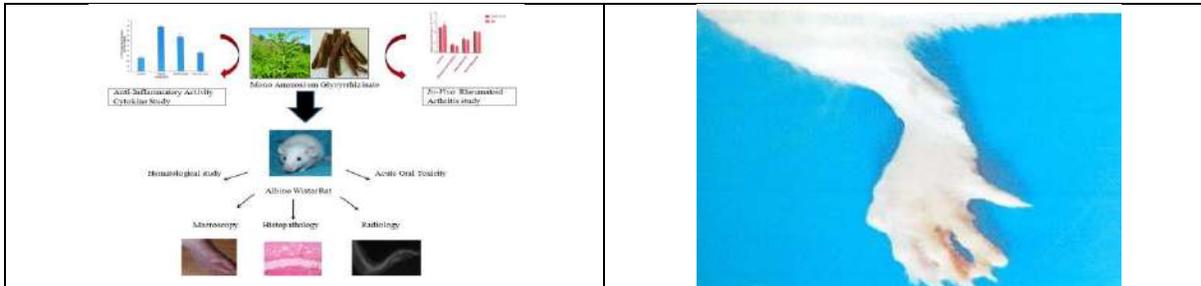
Figure 1: Paw in control group *Albino wistar* rat

Figure2: Paw oedema induced by (CFA) in female *albino wistar* rat

Figure 3: Effect ofMAG(50mg/kg) in (CFA)in female *albino wistar* rat

Figure 4: Effect of MAG(100mg/kg) in (CFA)induced arthritis in female *albino wistar* rat

Figure 5 X-Ray of paw in control *albino wistar* rat

Figure 6 Effect of (CFA) rheumatoid arthritis in albino wistar rat

Figure 7 Effect Of (MAG50mg/Kg) Of CFA In *Albino wistar* rat

Figure 8 Effect of (MAG100mg/kg of (CFA) in *albino wistar* rat
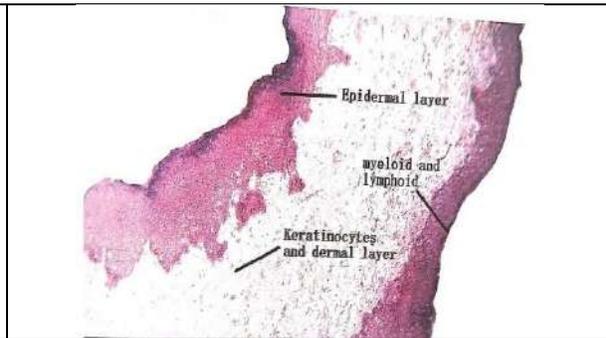
Figure 9 Histopathology of paw in control
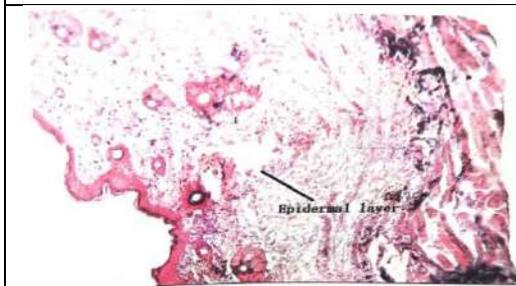
Figure 10 Histopathology of paw in disease control

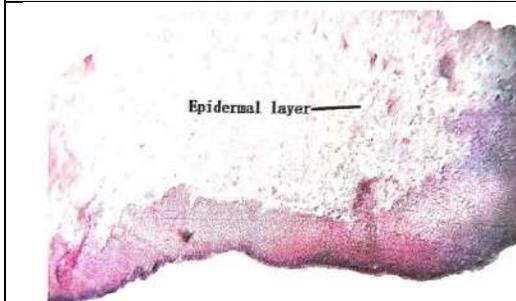**Figure 11 Histopathology of paw treated with MAG (50mg/kg)**
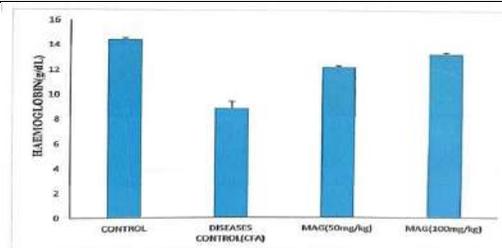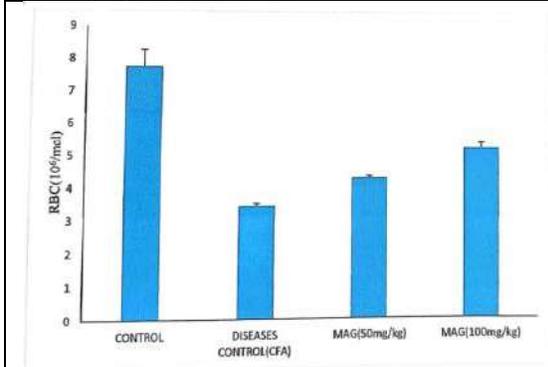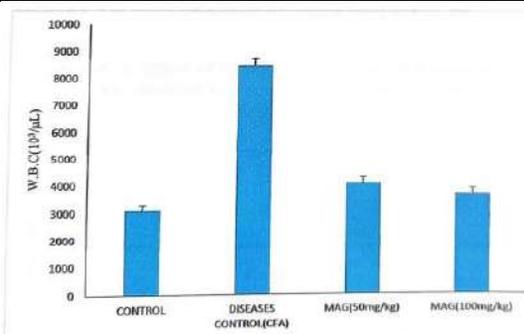

Figure 12 Histopathology of paw treated with MAG (100mg/kg)

Graph 1: Effect of MAG on Haemoglobin in CFA induced Rheumatoid arthritis in albino rats.
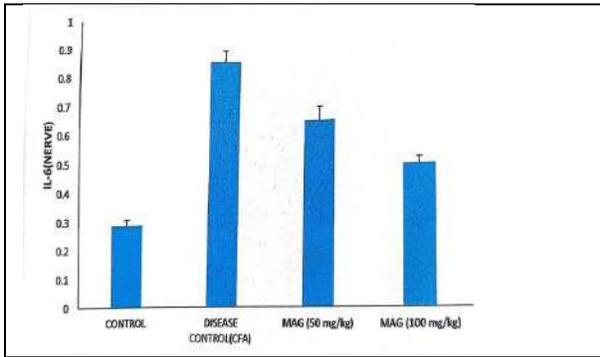

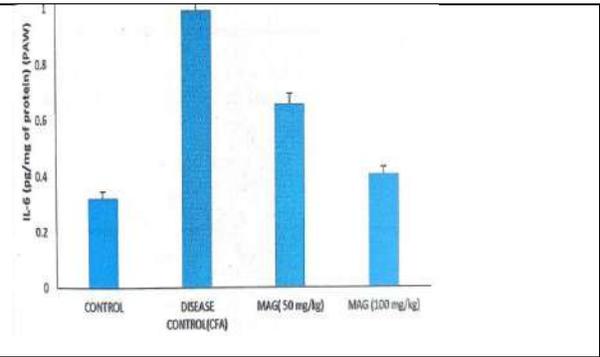**Graph 2: Effect of MAG on RBC in CFA induced Rheumatoid arthritis in albino rats.**

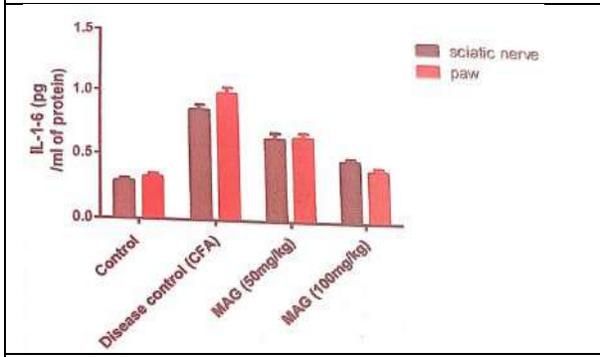**Graph 3: Effect of MAG on WBC in CFA induced Rheumatoid arthritis in albino rats.**
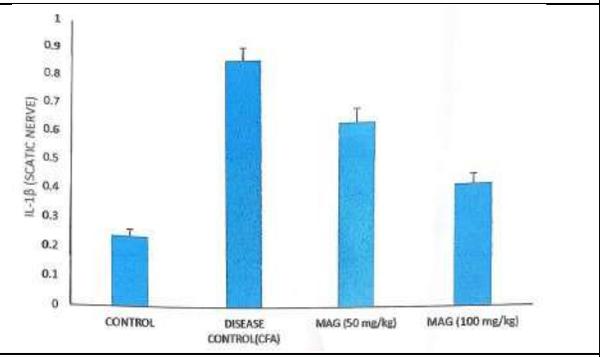
Graph 4: Effect of MAG on IL-6of sciatic never in CFA induced Rheumatoid arthritis in albino rats.
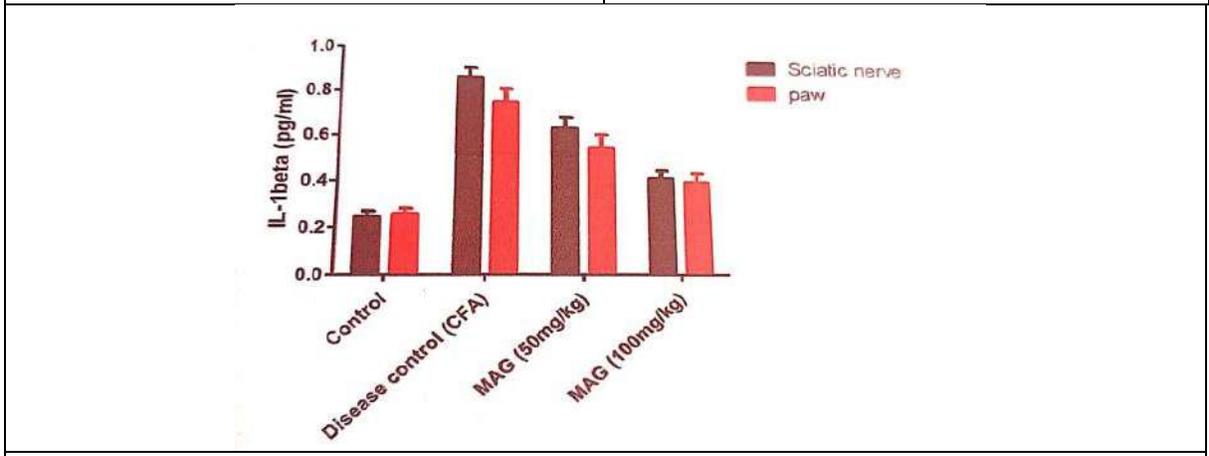

Graph 4: Effect of MAG on IL-6of sciatic never in CFA induced Rheumatoid arthritis in albino rats.

Graph 5: Effect of MAG on IL-6 of sciatic never and paw homogenate in CFA induced Rheumatoid arthritis in albino rats.

Graph6: Effect of MAG on IL-6 of sciatic never in CFA induced Rheumatoid arthritis in albino rats

Graph 7: Effect of MAG on IL- 1β of sciatic never and paw in CFA induced Rheumatoid arthritis in albino rats

RESEARCH ARTICLE

Estimation of Quality of Life in Kuraiveethana Noi (Hypothyroidsm) Patients with Add on Siddha Management Reporting at Ayothidoss Pandithar Hospital, National Institute of Siddha- A Cross Sectional Study

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ABSTRACT

Thyroid is an important endocrine gland located anterior to the Trachea. Hypothyroidism is 10 times
greater in women than man especially elder women. Hypothroidism causes sexual dysfunction, hyper
prolactenemia and depression in women. The adult onset of overt hypothyroidism significantly shows
neuropsychiatric symptoms affecting mood and cognition. It causes slowing of thought process and
speech, decreases attention, concentration, memory, perception and psychomotor function. Mood swings
and emotional disturbances are commonly found in hypothyroid patients. Weight gain and goiter
provokes discomfort and cosmetic concerns in women. Fatigue which is associated with quality of life is
more prevalent in hypothyroid patients. Exploring quality of life in chronic disease conditions especially
the diseases affecting physical and mental abilities is important. To estimate the quality of life [QOL] in
Kuraiveethananoi [Hypothyroidism] patients with add on siddha management attending Ayothidoss
Pandithar Hospital, NIS through Short Form Health Survey-36[SF36]. 50 Kuraiveethananoi
[Hypothyroidism] patients were included in this study based on inclusion and exclusion criteria. This
study was conducted at Ayothidoss Pandithar Hospital, National Institute of Siddha. Data related to
quality of life in Kuraiveethananoi [Hypothyroidism] patients were collected using Short Form Health
Survey -36 [SF-36]. The mean scorings of SF – 36questionnaire in 8 domains include general health-62.30,

physical function-72.40, physical limitations-66.10, emotional limitations-69.29, vitality-61.42, emotional well -being-65.04, social activities-68.30 and body pain-66.50. The mean scores of all the 8 domains were above 60. It is concluded that the quality of life of Kuraiveethananoi [Hypothyroidism] patients was good after taking siddha medications along with allopathy medications.

Keywords: Quality of life, Hypothyroidism, Kuraiveethananoi, Siddha Management

INTRODUCTION

Siddha is an ancient system of medicine flourished well among the Dravidians peninsular of south India[1]. The basic concepts of Siddha system include Aimpootham, Mukkuttram 96 thathuvam etc. In Siddha system of medicine Hypothyroidism is called as Kuraiveethananoi. The prevalence of Hypothyroidism is about 1% to 2% worldwide. Subclinical hypothyroidism accounts for about 8% in women and 3% in male stating that its prevalence is more common among women worldwide [2]. The prevalence in India is reported as 3.5% to 4.2%. The subclinical hypothyroidism reported in India is 8.02%-19.3% [3]. Hypothyroidism is common in women and older people. It affects 3 to5% of the adult population [4]. A study showed that quality of hypothyroid patients is impaired compared with controls of similar age and gender [5].A study in Amsterdam showed hypothyroid patients have lowered cognitive function, mental health and vitality compared to Dutch reference group [6]. Mood and emotional disturbances also significantly affect the HRQL in Hypothyroid patients. Goiter causes discomfort and cosmetic concern, fatigue and anxiety also impair the quality of life in Hypothyroid patients. So there is a need for the alternative medicines to improve the quality of life in Hypothyroid patients. Apart from the medicines, siddha system of medicine have therapies such as Yoga and Pranayama to improve the mental health and social behaviour. Assessing the quality of life of Kuraiveethananoi [Hypothyroid] patients become a foremost thing as it is a chronic disease. So the study was conducted to assess whether the quality of life Kuraiveethananoi [Hypothyroidism] patients is improved while taking siddha treatment along with allopathy medications. SF-36 was the scale employed in this study to assess the quality of life in Hypothyroid patients [7].

METHODS

It was a hospital based cross sectional study conducted in hypothyroid patients taking Siddha medications in Out Patient Department[OPD] of Ayothidoss Pandithar Hospital, National Institute of Siddha. This study was carried out after getting approval from ethics committee- NIS/IEC/2021/MP -1 [Institutional ethics committee] and also registered in CTRI-CTRI/2022/02/040071 [Clinical Trial Registry of India]. The study period was 6 months with the sample size of 50 patients. The sampling method used was purposive sampling. This study was conducted from February 2022 to April 2022. All the patients included in this study falls within the age group of18-50 years. Known case of Hyperthyroidism and CA thyroid patients were excluded from the study. Informed consent was obtained from before enrolment. The patients were given medicines for 3 months and the results were observed.

Short form [SF-36]
The health status of the pateints were assessed using Short Form -36 questionnaire. This includes questions under 8 different domain, namely General health, physical functioning, physical role limitations, emotional role limitations, Energy, social function and body pain. Each domain score were coded and summed to 0 [worst health status] to100 [best health status].

Data collection
All the participants are given a brief description about the study. Data collected regarding the Age, sex, social status, Demographic details, duration of the illness, treatments history, personal habits, symptoms etc**.,** and completed the SF-36 questionnaires during their visit to the OPD of Ayothidoss Pandithar Hospital.

Data Analysis

All the data collected were managed using an Excel sheet. Descriptive data were reported as a Mean and Standard deviation.

DISCUSSION

Hypothyroidism is one of the common diseases affecting the HRQL of the productive age groups and elderly people. Hypothyroidism is a chronic condition which has greater impact on all metabolic functions and growth. In this study 42% of participants belong to the age group of 40-50 year and 65% to the age groups of 31-40 years old. 92% were female patients and 8% of male patients. 90% of the participants were from urban area and 10 % of participants from the rural area. 68% belong to lower socio- economic status and 57% were unemployed. All the pateints completed the Siddha treatment for 3 months. Song et al. had stated that hypothyroid or subclinical hypothyroid patients had reduced sleeping duration, longer latency and decreased satisfaction with their sleep. In the present study 86% had regular and good sleep [8]. 72% had family history of hypothyroidism. This shows that the person with family history of hypothyroidism can be screened. Hypothyroidism causes heavy bleeding, oligomenorrhea, amenorrhoea and irregular menstrual cycle [9]. In this study 77% of the women in the reproductive age groups have regular menstrual cycle. In this study 2% cases had history of Goiter, 12% were infertile, 32% were obese and 6% had peripheral neuropathy. An Indian study reported that 33% of the overt and 11% of the subclinical hypothyroidism patients were obese [10]. Among 50 patients, 5[10%] cases had hypertension, 1[2%] cases had coronary artery disease, 2[4%] cases had bronchial asthma, 11[22%] cases had Diabetes mellitus, 1[2%] cases had psychiatric disease and 1[2%] had dyslipidemia. Pateints with TSH greater than 10uIU/ml indicates possibility of increased risk for cardiovascular disease proposed by American Academy of Clinical Endocrinology [11].

Previous study states that poor HRQL is due to fatigue [12]. In this study 68% had no complaints of fatigue after taking siddha medications. Depression also had impact in quality of life in hypothyroid patients. In this study 50% had complaints of depression. Elderly with subclinical hypothyroidism showed highest risk for depression [13]. Even with the use of levothyroxine, there is no significant improvement in depression in subclinical hypothyroid patients.[14] SF -36 questionnaire used in this study is a general health survey questionnaire to measure the quality of life with 8 domains. The mean scorings of SF – 36 questionnaire includes general health-62.30, physical function-72.40, physical limitations-66.10, emotional limitations-69.29, vitality-61.42, emotional well- being-65.04, social activities-68.30 and body pain-66.50. Sivaprasad et al. conducted a study in Indian population. The mean scores of each domain in SF-36 scale was 57.3 in general health domain, 51.9 in physical function domain, 65.2 in physical limitations domain, 77 in emotional limitations domain, 60.4 in vitality domain, 63.2 in emotional well- being domain,76.6 in social activities domain and 60 in body pain domain. By comparing the data of the above mentioned study with the present study, improvement noted in the physical function, General health, body pain and social function domains after taking siddha medications. Siva prasad et al, stated that the quality of life of hypothyroid patients were impaired even after the adequate replacements by comparing with the general population. It also states that there is worse health status negatively associated with the TSH levels in blood.[12]Limitations of the study is that this study was conducted only in 50 patients. Further, this study needs to be conducted in larger sample size.

CONCLUSION

As all of the mean scoring of SF-36 was observed as >50, which indicates that the quality of life is good after taking Siddha medications along with Allopathy medicines. Hypothyroidism affects the quality of life significantly. Depression, impaired memory and muscle weakness were the symptoms persistent even after treatment. Goiter and obesity provokes cosmetic concern. These factors negatively influence the quality of life. Hence along with medications, consistent yoga therapy may help to improve the mental well-being of the patients. Healthy diet may also support to improve the health status of the hypothyroid patients.

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Table I: Factors observed among the Hypothyroid patients

Observed factor	Predominant category	Percentage
Age	41-50 years	42%
Sex	Female	92%
Socio-economic status	Lower class	68%
Sleep pattern	Regular	86%
Menstrual cycle	Regular	48%
Family history	Yes	72%
Menopause	Attained	30%

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Table II: Medicines Followed by patients

Medications	Dosage and Adjuvent
Kazharchichooranam	2g bd with honey
Pavalaparpam	200 mg with honey
Mandurathykudineer	5g bd made into decoction
Thanneervittannei	5 ml bed with milk

Graph I : Duration of Hypothyroidism

Graph II: Distribution of Age

Graph III : Thyroid profile After treatment

Graph 3:Symptoms of Hypothyroidism Patients after treatment

Graph 4: Graphical representation of quality of life of Hypothyroidism patient

RESEARCH ARTICLE
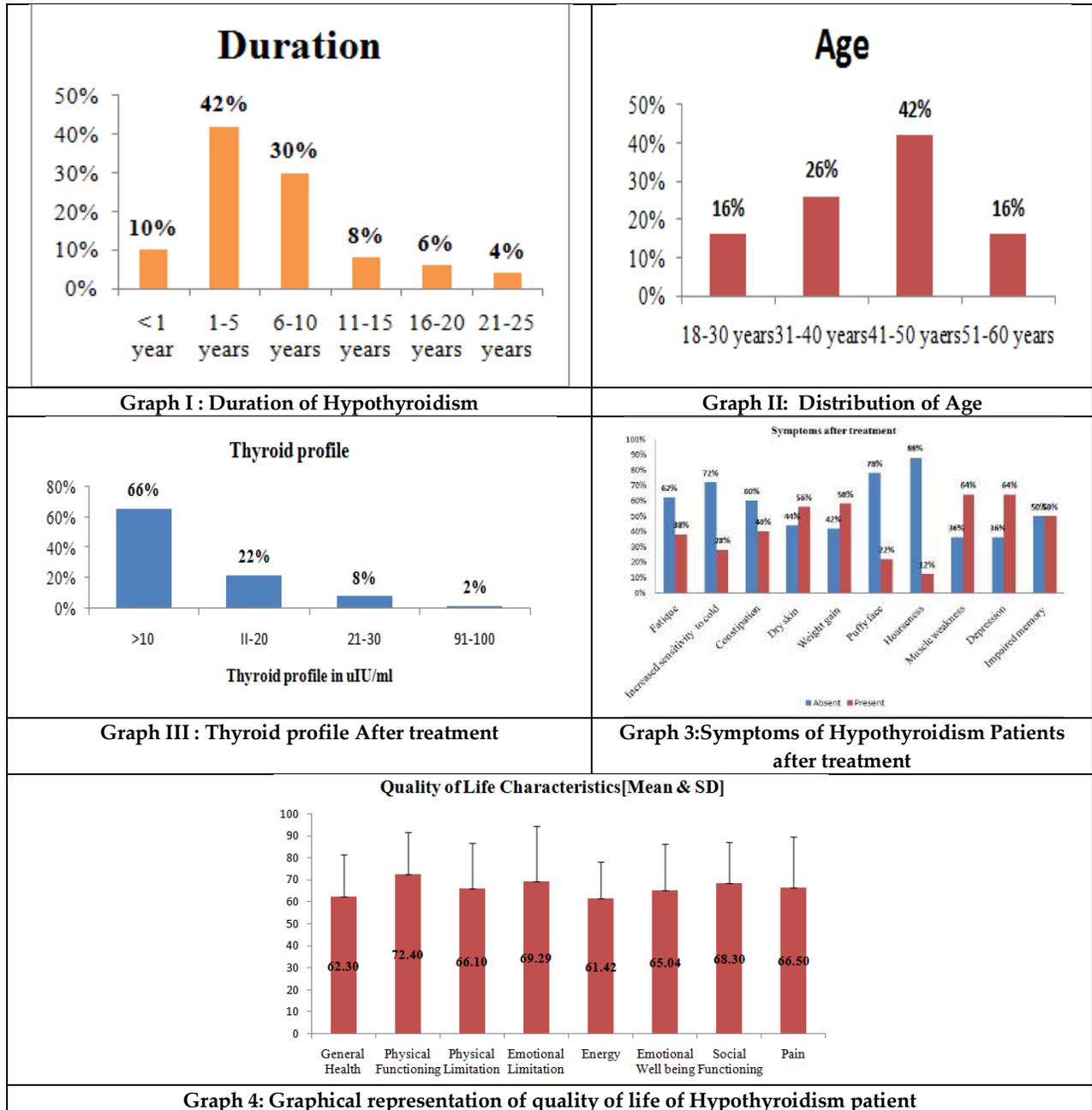
Amplifying GAN's Performance: Enhancement in Architecture and Training

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ABSTRACT

Generative Adversarial Networks (GANs) are a type of deep learning model that has received significant attention recently for their ability to generate realistic synthetic data. GANs consist of two neural networks, a generator, and a discriminator, that are trained in an adversarial setting to produce high-quality samples. The generator network generates fake samples, while the discriminator network tries to distinguish between the fake and real samples. Through iterative training, the generator learns to produce increasingly realistic samples that can fool the discriminator. This article discusses the different techniques that can be used to improve the performance of the GAN. Furthermore, this article examines some of the challenges and limitations of GANs, such as mode collapse and instability. It proposes future research directions, such as improving the quality and diversity of the generated samples and developing more interpretable and explainable models.

INTRODUCTION

Deep learning has witnessed remarkable progress in recent years, enabling machines to learn and extract meaningful representations from vast amounts of data. One exciting area of research within deep learning is Generative Adversarial Networks (GANs), a framework proposed by Good fellow et al. in 2014 [1]. GANs have revolutionized the field of generative modeling, providing a novel approach to learning and generating data that faithfully captures the underlying distribution of real-world examples.

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The fundamental concept behind GANs lies in the interplay between two neural networks: the *generator* and the *discriminator*. The generator network synthesizes new samples from random noise to deceive the discriminator into classifying them as real. Simultaneously, the discriminator network learns to differentiate between real and generated samples, striving to identify the true data distribution correctly. This adversarial process gradually improves the generator's ability to create increasingly realistic samples while the discriminator becomes more efficient in distinguishing real from fake. GANs have gained immense popularity in recent years due to their impressive capabilities in generating visually compelling images, synthesizing realistic videos, translating images across domains, and even generating text and speech. Moreover, GANs have found applications in data augmentation, anomaly detection, style transfer, and many other areas [2]. However, the training of GANs remains a challenging task, often plagued by issues such as mode collapse, instability, and hyper parameter sensitivity. This research paper aims to comprehensively review GANs, covering their fundamental principles, training challenges, and architectural variations. It discusses the diverse applications of GANs across multiple domains, highlighting their impact on Computer vision, Natural Language Processing, and Healthcare. This article also delves into recent advancements in GAN research, including techniques to address training instabilities, evaluate GAN performance, and incorporate additional information into the generative process. This review aims to provide researchers and practitioners with a comprehensive understanding of GANs, their underlying principles, and their vast potential for future advancements. By exploring the advancements and applications of GANs, this article aims to inspire further research and foster the development of innovative solutions that harness the power of generative modeling for real-world challenges.

BACKGROUND
Generative Adversarial Networks
The GAN framework consists of two main components: a generator network and a discriminator network. The generator aims to create synthetic samples that resemble real data, while the discriminator's role is to distinguish between real and fake samples. The two networks are trained in an adversarial manner, competing against each other to improve their respective performances as in Fig .1 [3]. The different stages explaining the working of a GAN is as follows

Initialization
The generator and discriminator networks are initialized with random weights. The generator takes a random noise vector (latent space) as input and produces a synthetic sample, while the discriminator takes a sample (real or fake) and outputs a probability score.

Training Process
1. **Real Sample Discrimination** In the first step, a batch of real samples from the training dataset is fed to the discriminator. The discriminator computes the probabilities for each sample being real and updates its weights to improve its ability to distinguish real samples [4].
2. **Synthetic Sample Discrimination** The generator network generates a batch of synthetic samples by taking random noise as input. These synthetic samples, along with some real samples, are fed to the discriminator. The discriminator updates its weights to improve its ability to differentiate between real and fake samples [4].
3. **Generator Improvement** The generator network is trained to fool the discriminator. It takes random noise as input and aims to generate synthetic samples that the discriminator incorrectly classifies as real. The generator's weights are updated based on the discriminator's feedback to improve its ability to generate realistic samples.
4. **Adversarial Training** The generator and discriminator continue to improve their performances through adversarial training iteratively. Steps 1-3 are repeated for multiple iterations, allowing both networks to learn and improve over time.

CHALLENGES IN TRAINING GANS

Training Generative Adversarial Networks (GANs) can be challenging due to several reasons:

Convergence

The training process continues until a convergence point is reached, where the generator produces synthetic samples that are highly realistic, and the discriminator is unable to distinguish between real and fake samples effectively.

Mode collapse

This occurs when the generator learns to produce a limited number of samples, which are repeated frequently instead of generating diverse and varied samples [5]. This can occur when the discriminator is too powerful and the generator cannot learn from the feedback it receives.

Instability

GANs are notoriously difficult to train, as the optimization problem is non-convex and can result in unstable behavior [6]. This can lead to oscillations in the loss function, and the generator and discriminator may become stuck in a suboptimal equilibrium.

Training time

Training GANs can be computationally expensive and time-consuming, especially when dealing with large datasets or complex models.

Over fitting

Like any deep learning model, GANs can over fit the training data, resulting in poor generalization performance.

Hyper parameter tuning

GANs have several hyper parameters that must be carefully tuned to perform well [7]. These hyper parameters include the learning rate, batch size, number of training iterations, and the architecture of the generator and discriminator networks.

Evaluation

It can be difficult to evaluate the performance of a GAN objectively, as there is no clear metric to measure the quality of the generated samples [8]. Some common evaluation methods include visual inspection, computing the *Frechet Inception Distance* (FID), or using human evaluators. In summary, training GANs can be challenging due to non-convex optimization problems, instability, training time, over fitting, mode collapse, hyper parameter tuning, and evaluation difficulties. However, with careful design and training, GANs can generate realistic and diverse samples that match the characteristics of a given dataset.

METHODOLOGY

There are several ways to improve the performance of Generative Adversarial Networks (GANs):

Adjust the architecture:

The architecture of the generator and discriminator can be modified to improve the performance of the GAN, like,

- Adding more layers to the generator can help it generate more complex samples.
- Adding more layers to the discriminator can help distinguish between real and fake samples better.

Increase the training time:

GANs require a lot of training time to achieve good performance.

- Increasing the number of epochs
- Increasing the amount of data used to train the GAN can improve its performance.

Use better optimization algorithms:

Using optimization algorithms like Adam, which can adapt the learning rate based on the gradients, can improve the convergence rate and stability of the GAN. Some of the alternate optimizers are

- Adagrad
- Adadelta
- RMSprop

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Use regularization techniques:
Regularization techniques like *weight decay*, *dropout*, and *batch normalization* can help prevent over-fitting and improve the generalization of the GAN [9].

Use alternative loss functions:
Alternative loss functions like *Wasserstein loss* or *hinge loss* can help improve the training stability of the GAN [10].

Use pre-training:
Pre-training the generator or discriminator on a related task can help initialize the network weights and improve the performance of the GAN.

Use data augmentation:
 Data augmentation techniques like *rotation*, *scaling*, and *flipping* can increase the diversity of the training data and improve the performance of the GAN.

Use conditional GANs:
Conditional GANs, where the generator and discriminator are conditioned on additional information like *class labels*, can generate more realistic samples and improve the performance of the GAN in certain applications [11].

Conditional Generative Adversarial Networks (cGANs)
Conditional Generative Adversarial Networks (cGANs) are an extension of the original GAN architecture that allow the generator and discriminator to be conditioned on additional information, such as class labels, attributes, or other features. This allows the GAN to generate samples that are not only realistic but also match a specific class or attribute. The main idea behind cGANs is to introduce a new input to both the generator and discriminator networks, which represents the additional information [12]. For example, in a dataset of handwritten digits, this input could be the class label of the digit (i.e., the number it represents). The generator takes as input both the noise vector z and the additional information y, and produces a fake sample x. The discriminator takes as input both the real or fake sample x and the additional information y, and produces a binary output indicating whether the sample is real or fake.

$$J(D) = -\frac{1}{2}E_{x \sim p_{data}} \log D(x) - \frac{1}{2}E_z \log(1 - D(G(y))) \tag{1}$$

$$J(G) = -\frac{1}{2}E_y \log(D(G(y))) \tag{2}$$

where, J(D) indicates the Loss function of the Discriminator network, J(G) indicates the Loss function of the Generator network, D(x) indicates the probability of 'x' to be real, G(y) indicates accuracy of the samples generated, Z indicates random noise induced while training. During training, the objective of the discriminator is to correctly classify real and fake samples, while also correctly classifying the additional information y. The objective of the generator is to produce samples that are not only realistic but also match the additional information y. The loss function for the generator in a cGAN is typically a combination of the binary cross-entropy loss and the additional information loss [13]. The binary cross-entropy loss measures how well the discriminator can distinguish between real and fake samples. In contrast, the additional information loss measures how well the generator can match the additional information y. The steps involved in training a cGAN are as follows:

for number of training iterations **do**
 for k steps **do**
  - Sample mini batch of m noise samples $\{z^1,…,z^m\}$ from noise prior $p_g(z)$.
  - Sample mini batch of m examples from data generating distribution $p_{data(x)}$
  - Update the discriminator by reducing its stochastic gradient as

$$\nabla_{\theta_d} \frac{1}{m} \sum_{i=1}^{m} [\log D(x^i) + \log(1 - D(G(y^i)))]$$

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end for

- Sample minibatch of m noise samples $\{z^1,\ldots,z^m\}$ from noise prior $p_g(z)$.
- Update the generator by descending its stochastic gradient as:

$$\nabla\theta_g \frac{1}{m}\sum_{i=1}^{m} \log(1 - D\left(G(z^i)\right))$$

end for

cGANs have been used in a variety of applications, such as image synthesis, image-to-image translation, text-to-image synthesis, and speech synthesis [14]. They have been shown to produce high-quality samples that match the specified class or attribute, and are often used in situations where it is important to control the output of the GAN.

RESULTS AND ANALYSIS

With the knowledge gained from the extensive analysis made on the existing works, a comparison has been made to exhibit the difference in performance between an Unconditional GAN and Conditional GAN(Fig 2). For experimentation purpose the dataset that has been implemented is Fashion MNIST dataset. This dataset comprises of 60,000 small grayscale images of the size 28x28 pixels. It is a collection of clothing images that belongs to 10 different classes, namely, t-shirts, shoes, dresses, etc. This experiment consists of two phases. In the first phase, the Fashion MNIST dataset is fit into a regular Unconditional GAN model and in the second phase the same dataset is fit into a modified Conditional GAN model. The following parameters are set while training the model:

1. Activation Function: LeakyReLu
2. Stride: 2 x 2
3. Optimizer: Adam
4. Learning Rate: 0.0002
5. Momentum: 0.5

These parameters are chosen based on the experiments conducted in another research relevant to this work [15][16]. The structure of the Generator network and Discriminator network of the regular GAN built and trained in this experiment is given in Table 1 and Table 2. The structure of the Generator network and Discriminator network of the regular cGAN built and trained in this experiment is given in Table 3 and Table 4. The Loss values obtained while training the Discriminator network over Real Image samples from the dataset fed on GAN vs. Conditional GAN are plotted as shown in Fig 3. The objective is to reduce the loss value while maintaining the accuracy of regenerating the image samples flawlessly. It is observed that Conditional GAN has reduced outliers while trained over the same number of iterations as the Unconditional GAN. A similar pattern of reducing outliers is observed in the Loss values obtained while training the Discriminator network of GAN vs.cGAN over a set of Fake images (Fig.4). Fig. 5 shows the Loss values obtained while generating new image samples using the Generator Network of GAN vs Conditional GAN. The outliers are removed and the values are better distributed showing an improvement in the performance of cGAN in comparison to a GAN. Fig.6 and Fig.7 show the difference in performance between an Unconditional GAN and a Conditional GAN. The objective is to generate image samples that are similar to the input images. The reduction of fluctuations in the loss values of the Generator network in the Conditional GAN (Fig.7) indicates that the network has developed the ability to generate better samples. The Samples generated by Unconditional GAN and Conditional GAN is given in Fig.8 and Fig.9. It is observed from the images generated by an Unconditional GAN that some of the images are not complete and makes it difficult to identify the category of the image sample it intends to generate. Such a sample is highlighted in Fig.8. This discrepancy has been eliminated while generating images using a Conditional GAN neural network, as in Fig.9.

SCOPE FOR FUTURE RESEARCH

Conditional Generative Adversarial Networks (cGANs) have shown tremendous potential in various applications where the generation of specific outputs based on given conditions is required. However, there are several future challenges that researchers and practitioners need to address to improve further and effectively utilize cGANs. Some of these challenges include

Data scarcity and imbalance

Conditional GANs typically require paired data, where both the input condition and the corresponding output are available. However, acquiring paired data can be challenging and time-consuming, especially in domains where the data is scarce or imbalanced. Developing effective techniques for training cGANs with limited or unpaired data is a significant challenge.

Mode collapse in conditional generation

Mode collapse, where the generator produces a limited variety of outputs, can also occur in conditional generation tasks. This can result in the generator generating similar outputs for different input conditions, reducing the diversity and quality of the generated samples. Developing methods to mitigate mode collapse in cGANs is crucial to ensure that the generator can capture the full range of possible outputs for different input conditions.

Interpretability and controllability

Understanding and controlling the output of a cGAN is another challenge. As the generator learns the mapping from input conditions to outputs, it becomes essential to provide interpretable and controllable ways to manipulate the conditions and guide the generation process. Techniques for disentangling factors of variations and ensuring controllability in cGANs need further exploration.

Scalability to high-dimensional and complex conditions

Many real-world applications involve high-dimensional and complex input conditions, such as images or videos with multiple attributes or complex textual descriptions. Designing cGAN architectures and training strategies that can effectively handle such high-dimensional and complex conditions is a challenge that needs to be addressed.

Evaluation metrics for conditional generation

Assessing the quality and performance of cGANs in conditional generation tasks is a non-trivial task. Developing appropriate evaluation metrics that can capture the fidelity, diversity, and controllability of the generated outputs for different input conditions is crucial to objectively measure the effectiveness of cGAN models.

Robustness to noisy and incomplete conditions

Real-world conditions can be noisy or incomplete, introducing uncertainty and challenges in conditional generation tasks. Ensuring the robustness of cGANs to handle noisy or incomplete input conditions is an important challenge that requires designing models capable of handling such variations and providing reliable outputs. Addressing these challenges will contribute to advancing the field of conditional generative modeling and enable the effective use of cGANs in various applications, including image synthesis, style transfer, data augmentation, and many others. Overcoming these challenges will ultimately lead to more reliable and versatile cGAN models that can generate high-quality outputs based on specific conditions.

CONCLUSION

In conclusion, Generative Adversarial Networks (GANs) stand as a remarkable innovation in the realm of deep learning, captivating attention for their prowess in creating lifelike synthetic data. The interplay between the generator and discriminator networks, engaged in an adversarial dance, fuels the evolution of GANs to generate increasingly convincing samples. This article has delved into the arsenal of techniques available to enhance GAN

performance while shedding light on the challenges, including the notorious mode collapse and instability. As we navigate the frontier of GAN research, the call for improving sample quality and diversity echoes loudly, alongside the pursuit of models that are not just powerful but also interpretable and explainable. The journey of GANs is far from over; it's an evolving narrative with promises and challenges that continue to shape the landscape of artificial intelligence.

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Table 1: structure of the generator network (gan)

Layer No.	Layer Name	Output Shape	Number of Parameters
0	dense_1	6272	633472
1	leaky_re_lu_2	6272	0
2	reshape	7, 7, 128	0
3	conv2d_transpose	14, 14, 128	262272
4	leaky_re_lu_3	14, 14, 128	0
5	conv2d_transpose_1	28, 28, 128	262272
6	leaky_re_lu_4	28, 28, 128	0
7	conv2d_2	28, 28, 1	6273
Total number of Trainable Parameters:			11,64,289

Table 2: structure of the discriminator network (GAN)

Layer No.	Layer Name	Output Shape	Number of Parameters
0	conv2d	14, 14, 128	1280
1	leaky_re_lu	14, 14, 128	0
2	conv2d_1	7, 7, 128	147584
3	leaky_re_lu_1	7, 7, 128	0
4	flatten	6272	0
5	dropout	6272	0
6	dense	1	6273
Total number of Trainable Parameters:			1,55,137

Table 3: structure of the generator network (cGAN)

Layer No.	Layer Name	Output Shape	Number of Parameters
0	input_4	100	0
1	input_3	1	0
2	dense_6	6272	633472
3	embedding_1	1, 50	500
4	leaky_re_lu_9	6272	0
5	dense_5	1, 49	2499
6	reshape_3	7, 7, 128	0
7	reshape_2	7, 7, 1	0
8	concatenate_1	7, 7, 129	0

Layer No.	Layer Name	Output Shape	Number of Parameters
9	conv2d_transpose_2	14, 14, 128	264320
Total number of Trainable Parameters:			11,69,336

Table 4: Structure of the discriminator network (cGAN)

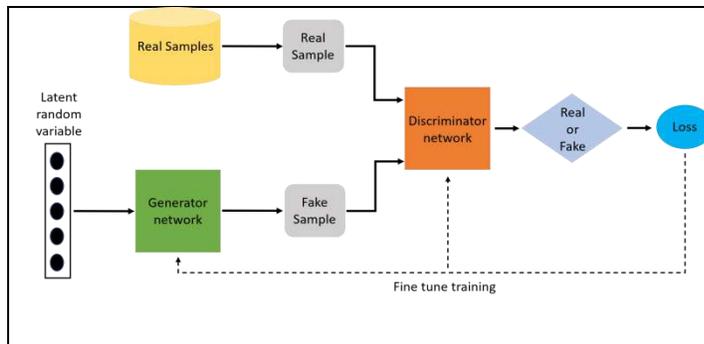| Layer No.	Layer Name	Output Shape	Number of Parameters
0	Input_1	1	0
1	embedding	1, 50	500
2	dense_3	1, 784	39984
3	Input_2	28, 28, 1	0
4	reshape_1	28, 28, 1	0
5	concatenate	28, 28, 2	0
6	con2d_5	14, 14, 128	2432
7	leaky_re_lu_7	14, 14, 128	0
8	conv2d_6	7, 7, 128	147584
9	leaky_re_lu_8	7, 7, 128	0
Total number of Trainable Parameters:			1,96,773

Fig. 1. Architecture of GAN

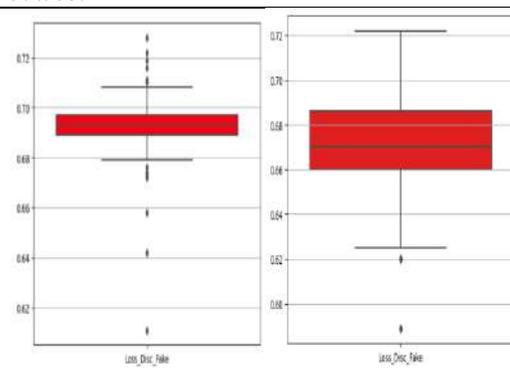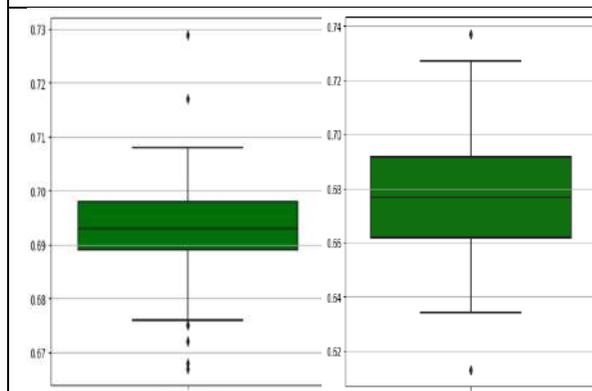

Fig. 2. Sample Images from Fashion MNIST dataset

Fig. 3. Loss values of the Discriminator for Real Images –

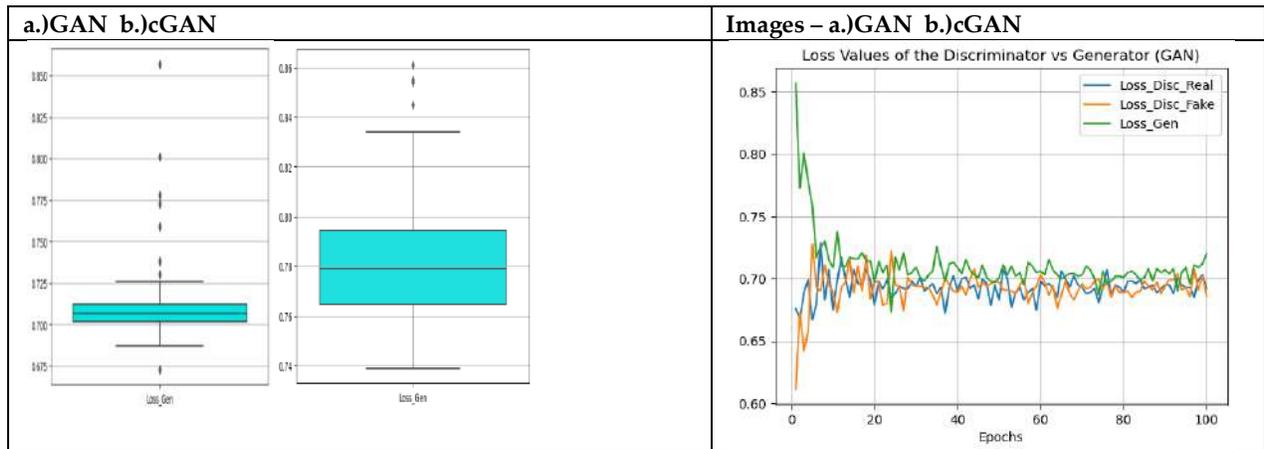**Fig. 4. Loss values of the Discriminator for Fake**

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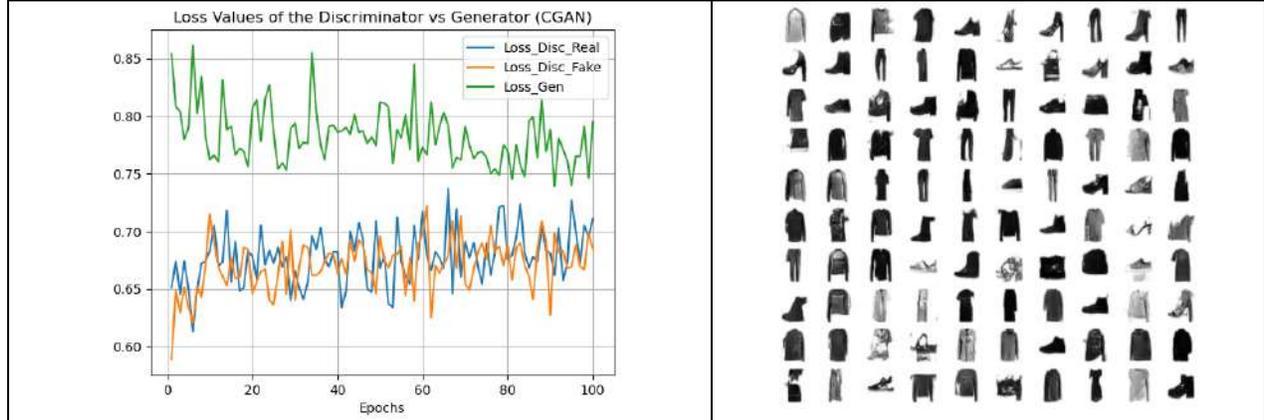| a.)GAN b.)cGAN	Images – a.)GAN b.)cGAN
Fig. 5. Loss values of the Generator for New Images – a.)GAN b.)cGAN	**Fig. 6. Loss values of the Discriminator vs Generator - GAN**
Fig. 7. Loss values of the Discriminator vs Generator - cGAN	**Fig. 8.New Images generated by Unconditional GAN**

Fig. 9. New Images generated by Conditional GAN

RESEARCH ARTICLE

Unveiling the Bio prospecting Potential of Green Synthesized Silver Nano Particles using Loquat Leaf Extract for Antibacterial and Anticancer Activities

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ABSTRACT

The recent rise of drug-resistant bacteria has created serious problems in the field of medicine, which necessitates research into efficient antibacterial medicines. Green techniques provide a lot of advantages over traditional physical and chemical ones and have several benefits, including being low-cost, energy-efficient, safe, and rapid and also provide tiny, biocompatible nanostructures with potential medical applications that include antibacterial and anticancer activities. The experimental study is to evaluate the efficacy of loquat leaf extract Silver nano particles for antibacterial and anticancer activity. The green synthesized silver nano particle was characterized using UV-vis Spectroscopy, X-Ray Diffraction, Fourier Transform Infrared Spectroscopy, and Scanning Electron Microscopy(SEM). The UV-Vis absorption spectrum was obtained for the silver nano particles of loquat leaf extract at 434nm due to the Surface Plasmon Resonance vibration confirmed the synthesis of silver nano particles. The structural peaks in the XRD pattern showed the average crystalline size around 16.5nm and FT-IR spectrophotometer peaks observed indicates the presence of O-H stretching group-alcohol, O-H Stretching carboxylic group, O=C=O,C=C alkene, N-O Stretching Nitro compounds OH bending phenols. The spherical shape has been found with the high resolution Scanning Electron Microscopy(SEM).The potential antibacterial action of AgNPs was determined by measuring the inhibition zone,(Micrococcus luteus-2mm, Vibrio Cholerae-2mm,Salmonella typhi-2mm,Shigella flexneri-3mm, Pseudomonas flurscens-1mm, and

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Escherichia coli-4mm).The use of AgNPs in biomedical applications as it depends on their safety, the in vitro cyto toxicity of the biosynthesized AgNPs on Vero cell line and MCF-7human breast cancer cell line using MTT [3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyltetrazoliumbromide] assay was done. The result of in vitro analysis showed that the AgNPs demonstrated dose-dependent cyto toxicity against the Vero Cell line and MCF-7 breast cancer cells but higher against the latter MCF-7 than the former Vero Cell line.

Keywords: Green synthesis, silver nano particles, loquat leaf, *Eriobotrya japonica,* Antibacterial activity, anti-cancer activity.

INTRODUCTION

The Metallic nano particles have been used extensively in biotechnology and in the biomedical area in recent years[1].It has been established that silver nano particles (Ag NPs) are a novel engineering tool with exceptional distinctive properties and morphologies. Due to the extremely high surface area to volume ratio of silver nano particles, especially those in 1-100 nm size range, its manufacture, application both are competent areas of scientific study. Diverse AgNP size ranges and shapes are required for diverse interactions with bacteria and viruses[2].Ag NPs have gained attention in recent years for their bactericidal and inhibitory activities against a variety of diseases[3].Tetracycline and streptomycin, two common medicine used as conventional antibiotics, have long been used to prevent bacterial infections. As the resistant power is developed in multi drug-resistant bacterial strains they are not inhibited by these antibacterial drugs. Therefore, it is deemed vital to create biomaterials that target microorganisms with bacterial antibiotic resistance. Comparatively, to traditional silver micro particles, AgNPs with large surface areas can offer a better interface for bacterial interaction. In the United States, nano silver has been utilized as a biocidal agent for more than a century in colloidal form of silver and silver nitrate[4].In contrast to other metal nano particles, silver-based nano products exhibit unique physical, chemical, and biological characteristics. It has a wide range of uses in the food industry, medicine, biomedical imaging, cosmetics, polymers and also as fungicidal and bactericidal agents[5].Plant-mediated nano particle synthesis is superior to microbial methods due to the availability, simplicity, and lack of cost[6].Loquat belongs to the family Rosaceae, species *Eriobotrya japonica,* genus *Eriobotrya,* order Rosales and they are grown for its fruit. Loquat is seen to bea shrub or a small tree. The tree grows up to 5-10metres tall and the leaves are dark green, tough and it's about 10-25cm long with a fuzzy texture. This study was designed with the loquat leaf extract silver nano particles that are eco-friendly, simple, and advantageous.

MATERIALS AND METHODS

Collection and Synthesis of Silver Nano particles using Loquat Leaf
Fresh loquat leaves were collected from the nearby place of Bodi, Tamil Nadu, India and washed repeatedly and dried. About 10gm of cleanly washed, dried, fine-cut leaves were boiled with 200ml of distilled water for 5 minutes till the color change from watery to light yellow color. The extract was allowed to be cooled at room temperature, then filtered with No1 what man filter paper and stored at the room temperature for further findings. Loquat leaf silver nano particles were synthesized by adding 5ml of loquat leaf extract with 100ml of 1×10^{-3} m aqueous $AgNo_3$ solution and heated at 80 0 c for 2 minutes till the change of color to brown.

Characterization Of Silver Nano particles
Uv-Vis Spectroscopy
UV-vis spectroscopy is most reliable technique for the primary characterization of synthesized nano particles which also helps to monitor the synthesis and stability of AgNPs[7].Synthesis of silver nano particles were confirmed by UV-Vis spectrophotometer at the wavelength of 250-600 nm (CHEMILINE CL – 1320 Spectrophotometer). Nano

particles are the very tiny materials having size ranges from 1 to 100 nm[8].Well-documented observations of this peak, which is attributed to a surface plasmon resonance, have been made for different kinds of metal nano particles with diameters ranging from 2 to100 nm.[9], [10].The UV-vis spectrum of synthesized AgNPs showed an intense absorbance peak at420nm due to the excitation of longitudinal plasmon vibrations in AgNPs solution[11].According to several findings, the surface plasmon resonance of AgNPs between 410nm and450 nm may correlate to spherical nano particles.([12],[13].A characteristic peak with strong absorption in the visible region forms for the metallic nano particle synthesized from a particular salt [14].The stability of silver nano particles produced through biological methods was examined for nearly 12 months and using UV-Vis spectro photometry a surface plasmon resonance peak at the same wave length was found.[15]

XRD
XRD is a common analytical technique for observing the crystalline structure of metallic nano particles by penetration of X-rays deeply into the material ([16], [17].The (XRD) data for the study were obtained using (RIGAKU – MINLFEEX – 600).The diffraction pattern obtained confirms the formation of nano particles with crystalline structure [18]. The particle size is calculated from the XRD data, using the Debye–Scherrer equation by determining the width of the Bragg reflection law according to the equation $D= K\lambda/\beta \cos\theta$, where D is the particle size(nm), K is the Scherrer constant, λ is the wavelength of X-ray, β is the (FWHM) full-width half maximum and θ(half of Bragg angle) is the diffraction angle that corresponds to the lattice plane [19]. XRD is a potent method for the study of nano materials [20].

FTIR
Fourier transforms infrared (FTIR) spectrophotometer (Model (Shimadzu, India) was used to characterize the functional Group and composition of AgNP at a range of 4,000 cm-1 to 400 cm -1.FTIR is a molecular vibration spectroscopy showing different chemical functional groups in different chemical classes[21].FTIR is a simple, appropriate technique that is an important cost-effective, non-invasive technique that determines the function of biological molecules in the reduction of silver nitrateto silver[15].FTIR can be utilized to explore the surface chemistry of synthesized metal nano particles and to observe the bio molecule and its involvement in nano particle synthesis and can be used in finding and analyzing different capping agents[16].In FTIR, the sample is subjected to infrared radiation, some of which are absorbed by the sample and some are not. The spectra got indicate the absorption and transmission that are characteristic of the sample material[22]

SEM
Scanning Electron Microscopy (SEM) analysis was carried out using a JEOL JSM- 6390 model at 20 kV. A thin carbon-coated film of the sample was formed as a small amount of the sample is placed on the copper grid. The extra moisture was removed using blotting paper and under a mercury lamp, the sample film placed on the SEM grid was dried for 5minutes before analysis[23].

Antibacterial activity of synthesized silver nano particles (Disc Diffusion Method, Heatly, 1944)[24]
About 0.3ml of green synthesized silver nano particles were applied to a 4mm sterile disc. Likewise, 4mm sterile discs were soaked in 0.3ml of amikacin for control. All the discs were allowed to dry at room temperature. Pathogenic bacterial strains were inoculated in sterile broth and incubated at 37°C for 24 hrs. Pathogens were swabbed and placed on the surface of 20ml of solidified nutrient agar in the sterile Petri dishes. The control and the experimental discs were placed in the sterile solidified nutrient agar petri plates to assess the effect of the silver nano particles on pathogens. These agar plates were incubated for 24 hours at 37°C and the antibacterial activity was measured based on the inhibition zone which were formed around the discs.

Cytotoxicity and Anticancer Activity[25]
Vero cell line and MCF-7 Cell lines were obtained from National Centre for Cell Sciences, Pune (NCCS). The cells were maintained in DMEM supplemented with 10% FBS, penicillin (100 U/ml), and streptomycin (100 µg/ml) in a humidified atmosphere of 50µg/mlCo 2 at 37°C.Cytotoxicity Analysis was done using the Vero cell line and the

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MCF-7 Cell line was used for the Anticancer Activity of the green synthesized silver nano particles using loquat leaf extract. Using 24-well plates the Cells (1×10^5/well) were plated and incubated at 37°Cwith5% CO_2 condition. When the cell reaches the confluence, the samples of various concentrations were added and incubated for 24hrs. After incubation, the sample was removed from the well and washed with phosphate-buffered saline (pH 7.4) or DMEM without serum.100μl/well (5mg/ml) of 0.5% 3- (4,5-dimethyl-2-thiazolyl)-2,5-diphenyl—tetrazoliumbromide (MTT) was added and incubated for 4 hours. After incubation, about 1ml of DMSO was added to all the wells. UV-Spectrophotometer was used to measure the absorbance at570nmwith DMSO as the blank. Measurements were performed and the concentration required fora 50% inhibition (IC50) was determined graphically. The % cell viability was calculated using the following formula:

% Cell viability = A570 of treated cells / A570 of control cells × 100
(A570 is Absorbance at 570nm).Graphs are plotted using the % of Cell Viability at the Y-axis and the concentration of the sample in X- axis. Cell control and sample control were included in each assay to compare the full cell viability assessments

RESULTS AND DISCUSSION

UV-Vis spectroscopy
The synthesized silver nano particles were confirmed by the change of color as shown in Fig1 and also by analyzing the excitation of surface plasmon resonance (SPR) using Shimadzu UV-vis spectrophotometer at 434 nm is shown in Fig 2

XRD
The particles crystalline nature was confirmed through analysis using X-ray diffraction, and the XRD pattern displayed several Bragg reflections. The XRD pattern obtained is shown in Fig 3.The XRD spectrum is well-matched to the standard JCPDS values and confirmed that the silver particles formed were in the form of nano crystals, as evidenced by the peaks at 2θ values of 38.2, 44.1, 64.1, and 77.6 θ, corresponding to (111), (200), (220) and (311), respectively Bragg reflections of silver, The X-ray diffraction results clearly show that crystalline silver nano particles were formed by the reduction ofAg+ ions by the loquat leaves extract. The Debye–Scherrer equation was used to determine the average crystallite diameter from half width of diffraction peaks and it clearly illustrates that AgNPs were nano crystalline. The average particle size and the fine structure of synthesized silver nano particles were identified using the Debye-Scherrer formula, $D=K\lambda/\beta\cos\theta$ Where D is said to be the mean crystallite size of AgNPs particles, λ is the wavelength of the x-ray source (0.1541 nm) used in XRD, β is the full width at half maximum of the diffraction peak, K is said to be the Scherrer constant with value from 0.9 to1, and θ is the Bragg diffraction angle. From the Debye–Scherrer equation, the average crystallite size of AgNPs synthesized is 16.5 nm.

FT-IR
Shimadzu FT-IR spectrophotometer peaks observed indicate the presence of various functional groups. The FT-IR spectra peaks are shown in Fig 4.The peak at 3855cm $^{-1}$ results due to the stretching of O-H stretching group-alcohol, The peak at 3724 cm $^{-1}$ and 3635 cm $^{-1}$indicates the O-H stretching, The peak at 2922cm $^{-1}$shows O-H stretching Carboxylic group, The shoulder peak shows 0=C=O group at 2341cm $^{-1}$,The peak at 1662cm $^{-1}$ is assigned for C=C stretching alkene, The peak at 1517cm $^{-1}$indicates the N-O stretching nitro group, The peak at 1392cm $^{-1}$ shows the O-H bending phenol, Thus the peak or prominent bands observed at 3855cm $^{-1}$, 2922cm $^{-1}$,2341cm $^{-1}$,1662cm $^{-1}$,1517cm $^{-1}$,1392cm $^{-1}$, 1068cm $^{-1}$, indicates the presence of O-H stretching group-alcohol, O-H Stretching carboxylic group, O=C=O,C=C alkene, N-O Stretching Nitro compounds, OH bending phenols and the shown functional groups mainly acts as a reducing agent and capping agent.

SEM
Fig 5. shows the SEM images of the green synthesized silver nano particles (AgNPs).The images of SEM clearly show that the AgNPs were spherical nano particles with an average diameter value of 16.5 nm

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Anti-bacterial effect

The potential antibacterial action of Ag NPs was confirmed by the measurement of the inhibition zone Micrococcus luteus-2mm, Vibrio Cholerae-2mm,Salmonella typhi-2mm,Shigella flexneri-3mm, Pseudomonas fluorescens-1 mm. This is shown in Table 1 and fig 6 and fig 7.AgNPs were regarded as a superior antibacterial agent. Because of its non-toxic effect on human cells and the weaker capacity of bacteria to develop resistance to silverions([26]–[28].The current investigation was carried out to investigate the growth-inhibitory effects of biosynthesized AgNPs against human pathogens, It was discovered that all human infections are effectively inhibited by biosynthesized AgNPs. Ag NPs enhanced antibacterial action is a result of their unique surface properties[29].According to several studies, silver nano particles may adhere to the cell membrane& surface, impairing the cells permeability and respiration processes. Smaller Ag NPs would have a greater bactericidal impact than larger Ag NPs due to their vast surface area accessible for interaction[30].It is also feasible that Ag NPs not only interact with the surface of the membrane but they also penetrate and interact with the interior of bacteria[31].The inhibitory mechanism of silver ions is unclear but still partially known. For Ag NPs and the bactericidal effect against bacteria, three potential pathways have been postulated. First, it is thought that Ag+ interferes with bacterial cell membranes through the process of plasmolysis, which inhibits the synthesis of cell membranes[31] Second, Ag NPs disrupt the thiol group of the bacterial cell, impairing cell division and ultimately causing death[32].Finally, Ag NP releases silver ions which would enter the cell wall and damage DNA by condensing and disrupting the protein synthesis[33] Consequently, the involvement of three potential processes may be responsible for Ag NPs and the bactericidal activity in this experiment. Ag NPs and the antimicrobial effect is influenced by the characteristics of different bacterial species.

The peptidogly can layer thickness , which is exclusively found in pathogenic bacteria, is the primary distinction between gram-positive and gram-negative bacteria. About membrane structure, it has sugar and amino acid polymer that forms the cell wall, or exterior of the plasma membrane, and it gives the structure strength to combat the cytoplasm osmotic pressure. Gram-positive bacteria have a 50% thickness and Gram-negative bacteria have an 8%thickness. As a result, Gram-positive bacteria have many peptidoglycan layers, no outer membrane, and lipo-polysaccharide, but they also have a lengthy chain of teichoic acids. Gram-negative bacteria, on the other hand, have a thin, single layer of peptidoglycan that is devoid of teichoic acid. According to reports, gram-positive and gram-negative bacteria strains are killed effectively by AgNPs[34].Gram-negative bacteria are more susceptible to destruction by AgNPs than gram-positive bacteria. As gram-negative bacteria have an outer layer of lipo polysaccharide (LPS), a thin layer of peptidoglycan, and an innermost plasma membrane only they are more susceptible to destruction, and Gram-positive bacteria have one cyto plasmic membrane and a cell wall that is relatively thick and made up of several peptidoglycan layers (20-80 nm)([35]–[37].

Cancer Activity

The green synthesized silver nano particles using the loquat leaf extract showed less cytotoxicity in the Vero cell line and showed higher cyto toxicity in the MCF-7 Cell line which helps us to find that there is more anticancer activity. This is shown in Table 2 and Table 3.Fig 8 and Fig 9 show the cyto toxicity of the Vero cell line and anti-cancer activity inthe MCF-7 cell line. One of the rapidly evolving and promising methods for combating cancer with metallic nano particles is Nano medicine. Due to unanticipated drug-related adverse effects, lack of specificity of low drug concentrations at the tumor target site, and the development of chemoresistance, current cancer treatments like chemotherapy and radiation therapy have limitations[38], [39].The greatest, most suitable, and also with alternative therapeutic approach for treating cancer is nanoparticle-mediated treatment. When therapeutic medicines are encapsulated in nanoparticles (NPs), they can target specific sick cells or tumor tissues either passively oractively. This property has led to their application as drug delivery systems[40].As there is less cytotoxicity in normal cells and higher cyto toxicity in cancer cells these green synthesized silver nano particles can be further used for application as a drug by conducting experiments in the future.

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CONCLUSION

The green synthesized silver nano particle using loquat leaf is a potential source for anti-bacterial activity as the zone of inhibition which clearly shows their effectiveness against the bacteria and as for as the Anti-cancer activity is concerned the silver nano particles are very effective in destroying those cells than the normal cell. This study further recommends for medical analysis in future research work.

Author Contributions

D. Kasthurisantira kumari conducted the experiments, analysis, writing, referencing, and editing of the manuscript and Iruthaya Kalai Selvam analyzed the results and revised..

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Table 1:AntiBacterial activity with the zone of inhibition of silver nanoparticles using loquat leaf

Human Pathogens	Zone of inhibition Experiment (mm)	Zone of inhibition Control (mm)
Escherichia coli	4	4
Micrococcus luteus	2	1
Vibrio Cholerae	2	2
Salmonella typhi	3	1
Shigella flexneri	3	2
Pseudomonas flurscens	1	1

Table 2:Cytotoxicity effect of Synthesized silver nanoparticles using loquat leaf*on Vero* cell line

S.No	Concentration (µg/ml)	Absorbance (O.D)	Cell viability (%)
1	1000	0.699	58.64
2	500	0.765	64.17
3	250	0.831	69.71
4	125	0.897	75.25
5	62.5	0.963	80.78
6	31.2	1.029	86.32
7	15.6	1.095	91.86
8	7.8	1.161	97.39
9	Cell control	1.192	100

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Table 3:Anticancer effect of Synthesized silver nanoparticles using loquat leaf *on MCF-7 cell line*

S.No	Concentration (µg/ml)	Dilutions	Absorbance (O.D)	Cell viability (%)
1	1000	Neat	0.086	12.21
2	500	1:1	0.121	17.18
3	250	1:2	0.157	22.30
4	125	1:4	0.192	27.27
5	62.5	1:8	0.228	32.38
6	31.2	1:16	0.263	37.35
7	15.6	1:32	0.304	43.18
8	7.8	1:64	0.343	48.72
9	Cell control		.704	100

Figure 1: The change of color from watery yellow to brown color showing the confirmation of synthesized Silver nanoparticles
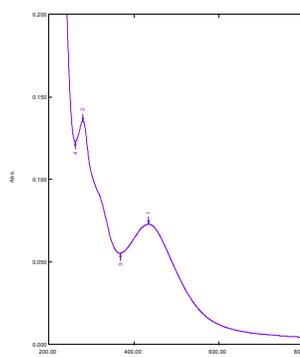

Figure 2:UV-Vis spectra showing the surface plasmon resonance at 434nm confirming the presence of silver nanoparticles
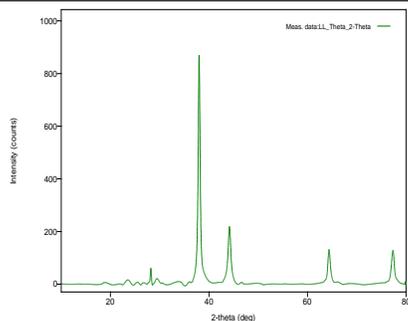

Figure 3: XRD Pattern of synthesized silver nanoparticle using Loquat leaf extract
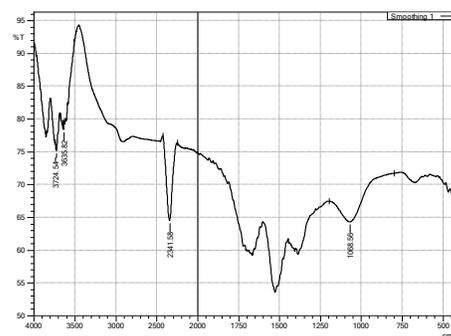

Figure 4:FT-IR Spectra of synthesized silver nanoparticles using loquat leaf showing different functional groups.
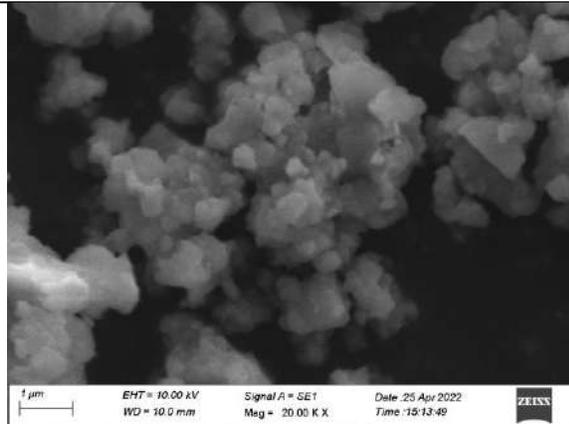
Figure 5:SEM Image of the synthesized silver nanoparticles using loquat leaf.

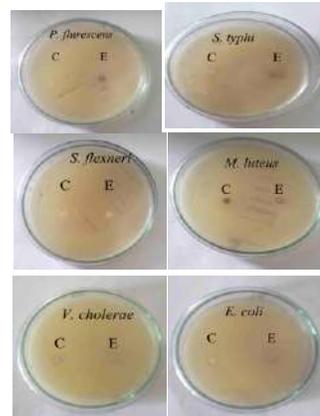Figure 6:The Antibacterial activity of synthesized silver nanoparticles using loquat leaf against *Micrococcus luteus*,*Vibrio cholera*, *Salmonella typhi*,*Shigella flexneri*, *Pseudomonas flurescens, and Escherichia coli*

Figure 8:Graphical representation showing the Cytotoxicity effect of Synthesized silver nanoparticles using loquat leaf *on Vero* cell line
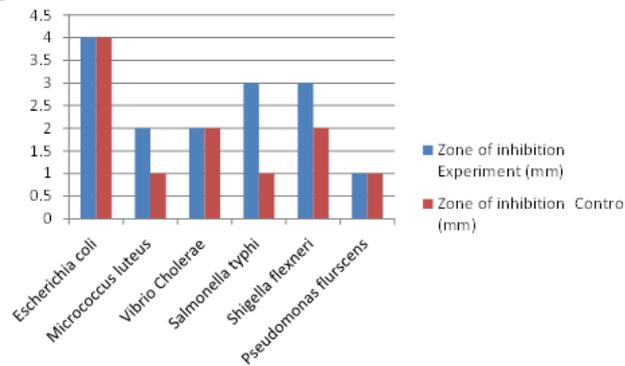
Figure 9: Graphical representation showing the Anticancer effect of Synthesized silver nanoparticles using loquat leaf *on MCF-7* cell line
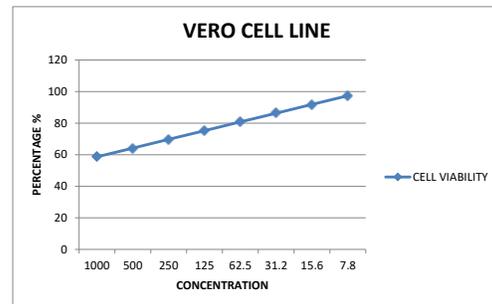
Figure 10: Cytotoxicity effect of Synthesized silver nanoparticles using loquat leaf*on Vero* cell line

Control

1000 µg/ml   7.8 µg/ml

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Figure 11:Anticancer effect of Synthesized silver nanoparticles using loquat leaf *on MCF-7 cell line*

Graphical Abstract with High Resolution

RESEARCH ARTICLE
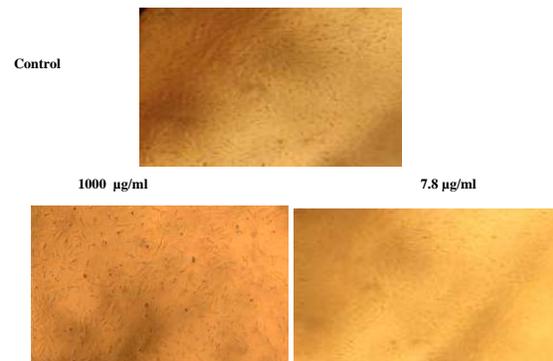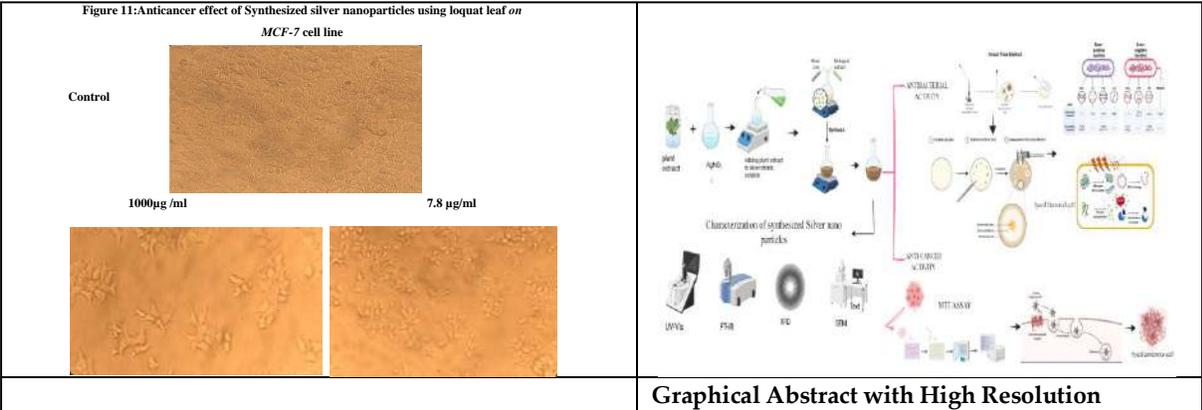
An Intelligent Brain Tumour Prediction Model utilizing Machine Learning and Deep Learning

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ABSTRACT

Tumours are a prevalent and consequential clinical phenomenon in modern civilization, presenting in various anatomical sites inside the human body. Brain tumours are the most prevalent of the numerous forms of tumours. The prompt detection of tumours through the utilization of magnetic resonance imaging (MRI) scans is of paramount significance in minimizing the probable mortality rate among patients. Deep Learning is a multidisciplinary domain including a diverse range of methodologies utilized to develop models capable of efficiently processing and analyzing visual data. This study employs many algorithms to develop a brain tumour detection model, aiming to provide doctors with accurate and efficient assistance in their decision-making processes. The model utilized in this work was subjected to training using a dataset of around 2870 photographs. The training procedure encompassed the application of deep learning and machine learning methods that are based on neural networks. The employed methodologies include Logistic Regression, Support Vector Machines (SVM), ResNet50, and Convolutional Neural Networks (CNN) with three, four, and five layers. The aim of this study is to establish a systematic and reliable method for detecting brain tumours using MRI scans, thereby assisting healthcare professionals in making informed clinical decisions.

Keywords: Brain Tumour, Convolutional Neural Networks, Logistic Regression, Support Vector Machine.

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INTRODUCTION

The human brain serves as a crucial organ that plays a pivotal role in governing the central nervous system and overseeing the many physiological activities of the human body. Brain tumours are neo plastic formations characterized by the aberrant proliferation of brain tissue, resulting in the formation of cellular masses. Brain tumours can be categorized into two main types: primary tumours, which start within the brain itself, and secondary tumours, also known as metastatic tumours, which develop in other parts of the body and subsequently spread to the brain. Tumours can be classified into two categories: benign or malignant. Malignant tumours are characterized by their cancerous nature and necessitate prolonged treatment such as radiotherapy or chemotherapy. The occurrence of headache is frequently observed as a prevalent manifestation of brain tumours, often accompanied by additional symptoms such as vomiting, auditory impairments, unilateral bodily weakness, gait instability, and alterations in cognitive function and behavioural patterns. This study employed a range of machine learning models and deep neural networks to assess their respective performance to detect brain tumours. The initial phase encompassed the utilization of Logistic Regression and Support Vector Machine models.

Logistic regression is a straightforward and comprehensible model that is well-suited for small datasets. It offers the ability to estimate probabilities and do feature selection. Support Vector Machines (SVMs) provide exceptional performance in high-dimensional environments, effectively mitigate the issue of over fitting, and provide a wide range of applications through the use of kernel functions.ResNet50 and Convolutional Neural Networks (CNNs) were utilized for more intricate jobs. Convolutional neural networks (CNNs) are widely recognized for their proficiency in extracting local information, acquiring hierarchical representations, and demonstrating translation invariance. The organization demonstrates exceptional proficiency in the field of image analysis and has successfully attained cutting-edge performance in several computer vision tasks. The ResNet50 architecture, which is a deep neural network using skip connections, effectively mitigates the issue of vanishing gradients and attains notable accuracy while maintaining a reasonable amount of parameters. Section 2 of this study examines a limited number of existing scholarly works in order to get insight into the underlying operational principles. part 3 provides a comprehensive overview of the methods employed, while part 4 presents the experimental data. Finally, section 5 concludes the study.

LITERATURE SURVEY

The research work by P. Kumar, B. Vijay Kumar focused about the detection of brain tumour to reduce the death rate. They conducted the research work in 4 stages. In the first stages, pre-processing is done by filtering algorithm, secondly the segmentation is done by using clustering algorithm, third feature extraction by Gray-Level Co-occurrence Matrix(GLCM). [1]. In Ref [2] the dataset has been examined by G. Cinarer, B.G. Emirogluby using machine learning techniques including Linear Discriminant Analysis (LDA), Support Vector Machines (SVM), Random Forest (RF), and KNN in the literature. In the experiment conducted by M. Sajjad, S. Khan, K. Muhammad, Deep learning models have, however, taken on a significant role in machine learning in recent years due to their ability to analyse complicated relationships in an efficient manner. In adifferent research, the classification of brain tumour classes (I, II, III, and IV) using the VGG-19 architecture yielded 0.90 accuracy and 0.96 average precision [3].A deep CNN-based method for automated brain tumour diagnosis and grading was proposed by Seetha, J., and S. S. Raja. Fuzzy C-Means (FCM) is the system's foundation for segmenting the brain, and from these segmented areas, texture and form characteristics were collected, which were then fed into SVM and DNN classifiers. The outcomes revealed that the method achieved 97.5% accuracy rate [4].M.Sasikala and N. Kumaravel suggested a genetic algorithm feature selection for wavelet feature set feature dimension reduction. The technique is centred on choosing the best possible features vector to feed into the chosen classifier, such as an artificial neural network (ANN) [5].Convolutional neural networks (CNN) and Grey Level Co-occurrence Matrix (GLCM) based features were used to create the brain tumour classification system reported by Widhiarso, Wijang, Yohannes Yohannes, and CendyPrakarsah. Energy, Correlation, Contrast, and Homogenity these four features were extracted from four angles

(0°, 45°, 90°, and 135°) for every image to feed them into CNN model. [6].For the categorization of brain tumours, Ozyurt, Fatih, et al. integrated CNN with neutrosophic set- expert maximum fuzzy (NS-CNN) sure entropy. For brain tumour segmentation, they employed the neutrosophic set-expert maximum fuzzy-sure entropy approach. These pictures were then given to CNN to extract features, and fed to SVM classifiers to be categorised as benign or malignant. 95.62% of their attempts were successful on average [7].Using a modified version of AlexNet CNN, Khawaldeh, Saed, et al. suggested a technique for non-invasively grading glioma brain tumours.

Whole-brain MRI scans were used for the classification procedure, and the labels applied to the pictures were applied at the image level rather than the pixel level. [8].Javaria Amin et al., utilized multiple machine learning and deep learning approaches. They used a transfer learning ResNet-50 model with average global pooling to deal with the gradiant vanishing and over fitting issues. [9].For the aim of detecting brain tumours from MRI images, the authors employed the DNN, KNN(for k=1 and k=3), LDA, and SMO algorithms. By using the DNN technique, they were capable to reach 0.97 as recall value, 0.97 as precision, 0.97 as f-measure, and 0.984 as AUC. By employing the KNN technique with k=1, they achieved a recall value of 0.955, a precision of 0.956, an f-measure of 0.955, and an AUC of 0.967. By using the KNN method with k=3, they obtained 0.864 as recall value, 0.892 as precision, 0.866 as f-measure, and 0.954 as AUC. By using the LDA method, they were able to attain 0.955 as recall value, 0.957 as accuracy, 0.955 as f-measure, and 0.983 as AUC. By using the SMO algorithm, they were able to get 0.939 for recall, 0.941 for accuracy, 0.963 for f-measure, and 0.939 for AUC [10].A hierarchical deep learning-based brain tumour classifier using CNN was developed by the authors for the current work.

Glioma, meningioma, pituitary, and no-tumor were the four classes into which the model separated the input. With a miss rate of 7.87%, the suggested model achieved an accuracy of 92.13%. For predicting glioma, meningioma, no-tumour, and pituitary, respectively, the accuracy is 92%, 92%, 90%, and 96%, and the miss rate is 8%, 8%, 10%, and 4% [11].A model for early brain tumour detection was developed by K. Salçin. Images from magnetic resonance imaging (MRI) have been examined to identify the tumor-bearing areas and categorise these areas according to the type of tumour they are. [12]. Using MRI images, a model to determine the kind of brain tumour was put out by S. Sarkar, et al. In order to classify the data, a 2D Convolutional Neural Network (CNN) was trained, and it effectively detected meningiomas, gliomas, and pituitary tumours with an overall accuracy of 91.3%. [13].A dataset of 10,000 images were used in the study by authors Hamza Rafiq Almadhoun and Samy S. Abu Naser. For the purpose of evaluating their models, they employed their model as well as Inception V3, VGG16, MobileNet, and ResNet models. [14].A model to identify brain tumours using MRI images was developed by the authors B. Kokila, M. S. Devadharshini, A. Anitha, and S. A. Sankar. The multitask classification using Convolutional Neural Networks (CNN) is ready to categorize and identify tumours. Using this CNN-based model, which achieved a 92% accuracy rate [15].Rashid made a research on clear view of the target area i.e the location occupied by tumor. He has introduced methods like Anisotropic filtering for noise removal, Support Vector Machine for segmentation and morphological operations to separate the injured area from the normal one. [16].

PROPOSED METHODOLIGY
Through this proposed model brain tumour at an early stage by applying best model out of four different machine learning and deep learning models. The block diagram of the proposed model has been shown in the figure1.

DATASET COLLECTION & DESCRIPTION
The image dataset is collected from Kaggle. It contains almost a total 2870 number of image files. The image files are from 4 different classes, those are , PITUITARY TUMOR, GLIOMA TUMOR , MENINGIOMA TUMOR ,NO TUMOR

Methods used for Brain Tumour Detection
By using this combination of machine learning and deep learning algorithms, along with appropriate data preprocessing techniques, the Brain Tumor Detection model aims to achieve accurate and reliable classification of brain tumor images, contributing to improved medical diagnostics and patient care. The mentioned algorithms used

for model training are Logistic Regression, Support Vector Machine (SVM), Convolutional Neural Network (CNN), and ResNet50.

Logistic Regression

The logistic regression, a general statistical model was actually developed by **Joseph Berkson**, in 1944[8] . In this proposed model Logistic Regression has been applied and its performances have been observed in details. The mathematical function used to represent Logistic Regression is the sigmoid \. The sigmoid function takes any real-valued number and maps it to the range (0, 1). It is commonly used in logistic regression to convert the output of a linear function into a probability value between 0 and 1. The sigmoid function is defined as follows in equation no 1:$\sigma(z) = 1 / (1 + e^{-z})$ (1)

where: $\sigma(z)$ represents the output probability (the predicted probability of belonging to the positive class).

z is the linear combination of the input features and their corresponding weights. It is given by: $z = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + ... + \beta_r x_r$

Support Vector Machine

In this phase Support Vector machine has applied and performance has been analyzed. The SVM algorithm was discovered by **Vladimir N.Vapnik and Alexey Ya.Chervonenkis**[9]. SVM can be used for Regression and Classification problem also. Here the problem is also a classification problems, so SVM can be used. The mathematical representation of Support Vector Machine (SVM) for binary classification can be described as follows: Given a training dataset with input features x_i (where i = 1, 2, ..., n) and corresponding binary class labels y_i (where y_i is either +1 or -1), the goal of SVM is to find the optimal hyper plane that best separates the two classes in the feature space. The hyper plane can be represented as equation no 2 $w \cdot x + b = 0$ (2)

w is the weight vector perpendicular to the hyper plane.

x is the input feature vector.

b is the bias term (intercept).

The decision rule for classifying a new data point x_i is based on the sign of the function $w \cdot x_i + b$:

If $w \cdot x_i + b > 0$, then the data point belongs to the positive class. If $w \cdot x_i + b < 0$, then the data point belongs to the negative class.

Convolution Neural Network

Yann LeCun came with the invention of Convolutional Neural Networks (ConvNets) in 1980[10]. Convolution Neural Network is normally used to classify image data. Here the dataset is an image dataset , so CNN is used to classify the image dataset.

1CNN with 3 Layers

This model contains 3 convolution layers, there is one max-pooling layer and one drop-out layer for each convolution layer. After that the images get flattened , those are sent to the dense layer. The model summary is given below

2 CNN with 4 Layers

This model contains 4 convolution layers, there is one max-pooling layer and one drop-out layer for each convolution layer. After that the images get flattened , those are sent to the dense layer. The model summary is given below :

3 CNN with 5 Layers

This model contains 5 convolution layers, there is one max-pooling layer and one drop-out layer for each convolution layer. After that the images get flattened , those are sent to my dense layer. The model summary is :

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ResNet50

ResNet50 is a specific variant of the Convolutional Neural Network (CNN) architecture known as Residual Network (ResNet). It was introduced by Microsoft Research in 2015 and won the Image Net Large Scale Visual Recognition Challenge (ILSVRC) that year. ResNet50 is one of the ResNet models, and the "50" in its name indicates that it has 50 layers.

RESULT ANALYSIS

In this phase all four models- Logistic Regression, Support Vector Machine, Convolutional Neural Network and ResNet50 have been built and trained on the brain tumour dataset. The outcomes and observations of the experiments have been represented in below section. The level of accuracy attained by each model in this investigation is presented as follows: The logistic regression model achieved an accuracy rate of 80%, while the support vector machine (SVM) model achieved an accuracy rate of 83%. The Convolutional Neural Network (CNN) model, consisting of three layers, achieved an accuracy rate of 88%. The CNN model, consisting of four layers, achieved an accuracy rate of 91%. The Convolutional Neural Network (CNN) model, consisting of five layers, achieved an accuracy rate of 88%. The ResNet50 model achieved an accuracy rate of 92%.

LOGISTIC REGRESSION

Here Logistic Regression is used to develop a model for brain tumorim age classification in   the following different 4 categories. The classification report of this model has shown in figure 3.

SUPPORT VECTOR MACHINE (SVM)

SVM is used here to develop the model for classifying the images in the following 4 classes : 1.'No Tumor', 2. 'Pituitary Tumor' 3. 'Glioma Tumor'4. 'Meningioma Tumor'. The classification report of this model has shown in the figure 4 below.

CONVOLUTIONAL NEURAL NETWORK (CNN)

CNN is one of the most efficient and accurate algorithm for dealing with image classification problem.

3-LAYERS CNN

Here , from the total images of the dataset 70% of images are used for training & 30% of images are used for testing. The variation of Loss and accuracy with the number of epochs are shown in the following figure 5 and 6. The classification report of this model has shown in the figure 7 below.

4-LAYERS CNN

Here , from the total images of the dataset 70% of images are used for training & 30% of images are used for testing. From a total of 2870 files 2009 files are used for training & 861 files are used for validation. The number of epochs in this model is 20. The testing score of the model is 0.9059233665466309 .The variation of Loss and accuracy with the number of epochs has shown in the figure 8 and 9 below. The classification report of this model has shown in the figure 10 below.

5-LAYERS CNN

Here , from the total images of the dataset 70% of images are used for training & 30% of images are used for testing. From a total of 2870 files 2009 files are used for training & 861 files are used for validation. The number of epochs in this model is 20. The testing score of the model is 0.888501763343811 . The variation of Loss with the number of epochs has shown in the figure 11 and 12 below. The classification report of this model has shown in the figure 13 below.

RESNET 50

In this phase from the total images of the dataset 80% of images are used for training and 20% of images are used for testing. From a total of 2870 files 2296 files are used for training and 574 files are used for validation. The number of epochs in this model is 10. The testing score of the model is 0.9216 . The variation of Loss with the number of epochs has shown in the figure 14 and 15 below.

CONCLUSION

In this work comprehensive approach for brain tumour detection from MRI scan images, employing a range of Deep Learning and Machine Learning algorithms has been presented. The models implemented, applying Logistic Regression, SVM, CNN with 4 layers, and ResNet50, have demonstrated promising results in accurately classifying brain tumour images. The achieved test accuracies showcase the effectiveness of the models, with CNN and ResNet50 achieving the highest accuracy rates of 91% and 92%, respectively. The classification report, along with the confusion matrix, provides detailed insights into the models' performance, offering precision, recall, F1-score, and support for each class. Additionally, visualizations of loss vs. epochs and accuracy vs. epochs highlight the successful training process of the models. These remarkable findings suggest that the developed models can be utilized with confidence to determine the presence of brain tumours in MRI scans, paving the way for improved medical diagnostics and patient care in the field of neuroimaging.

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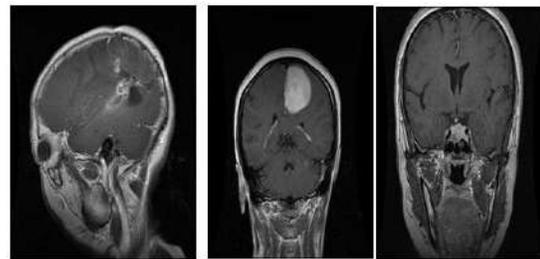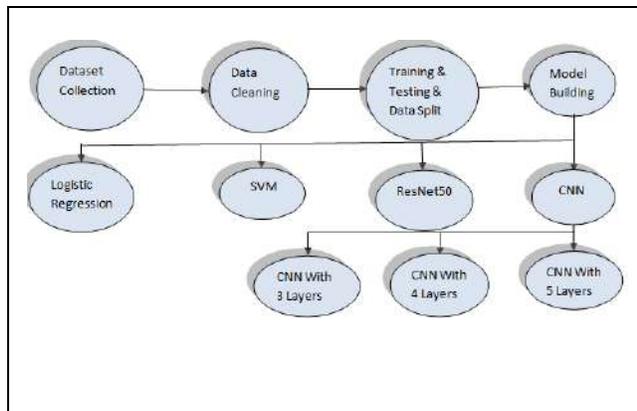| Pituitary Tumour	Glioma_Tumour	Meningioma Tumour	No Tumour
28.8%	28.8%	28.6%	13.8%

Fig 1. Proposed Model Block diagram	Fig 2. Sample Image in dataset

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	precision	recall	f1-score	support
0	0.79	0.75	0.77	91
1	0.89	0.94	0.91	162
2	0.77	0.83	0.80	145
3	0.77	0.70	0.73	176
accuracy			0.81	574
macro avg	0.80	0.80	0.80	574
weighted avg	0.81	0.81	0.81	574

Fig 3. The classification report of the Logistic Regression Model
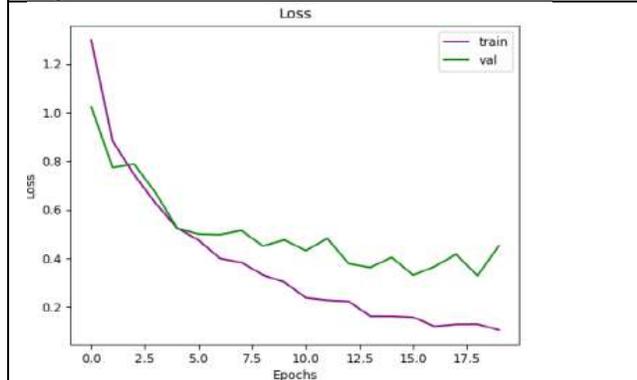
	precision	recall	f1-score	support
0	0.80	0.77	0.78	91
1	0.87	0.98	0.92	162
2	0.79	0.88	0.83	145
3	0.85	0.68	0.76	176
accuracy			0.83	574
macro avg	0.83	0.83	0.82	574
weighted avg	0.83	0.83	0.83	574

Fig 4. The classification report of the Logistic Regression Model

Fig 5. Variation of Loss with the number
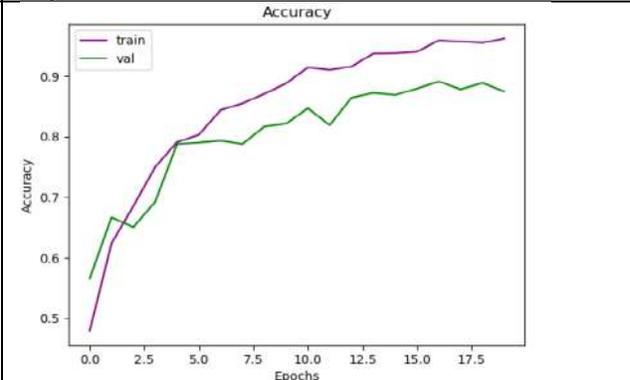
Fig 6. Variation of Accuracy with the number of epochs of epochs

	precision	recall	f1-score	support
Glioma	0.86	0.95	0.90	259
Meningioma	0.83	0.78	0.81	252
No tumor	0.92	0.70	0.80	114
Pituitary	0.92	0.97	0.94	236
accuracy			0.87	861
macro avg	0.88	0.85	0.86	861
weighted avg	0.87	0.87	0.87	861

Fig 7. Classification Report of 3L CNN Model

Fig 8. Variation of Loss
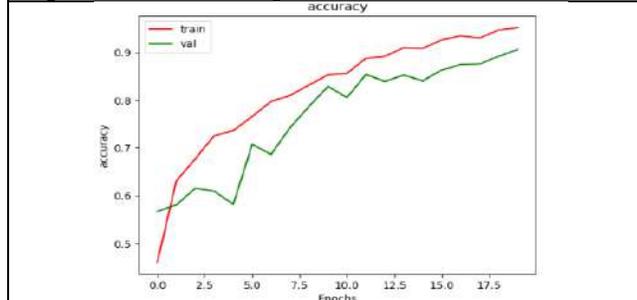
Fig 9. Variation of Accuracy
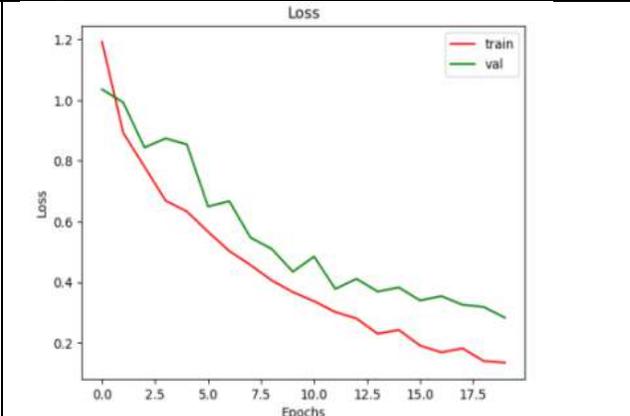
	precision	recall	f1-score	support
Glioma	0.90	0.96	0.93	259
Meningioma	0.88	0.82	0.85	252
No tumor	0.89	0.86	0.88	114
Pituitary	0.95	0.96	0.95	236
accuracy			0.91	861
macro avg	0.90	0.90	0.90	861
weighted avg	0.91	0.91	0.90	861

Fig 10. Classification Report of 4L CNN Model

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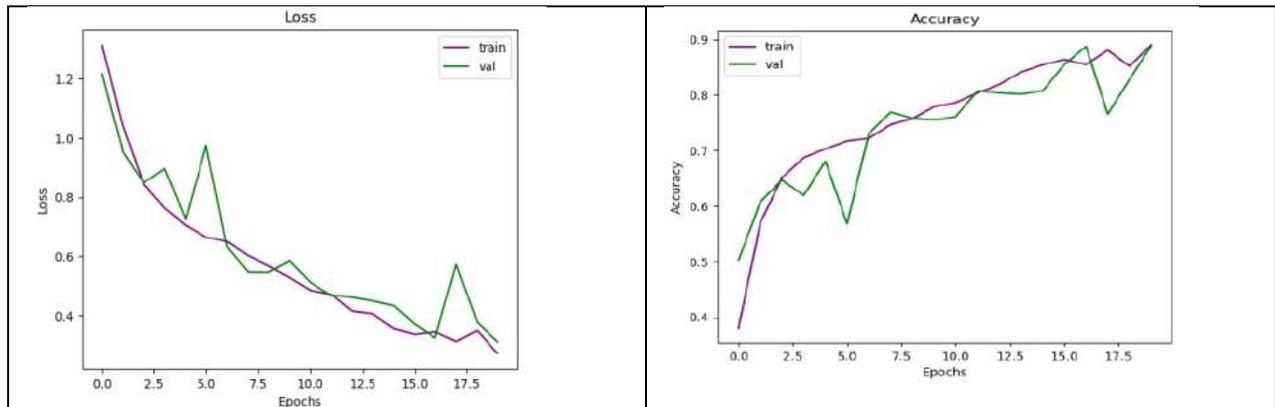
Fig 11. Variation of Loss

Fig 12. Variation of Accuracy

	precision	recall	f1-score	support
Glioma	0.90	0.87	0.89	259
Meningioma	0.81	0.87	0.84	252
No tumor	0.90	0.90	0.90	114
Pituitary	0.96	0.92	0.94	236
accuracy			0.89	861
macro avg	0.89	0.89	0.89	861
weighted avg	0.89	0.89	0.89	861
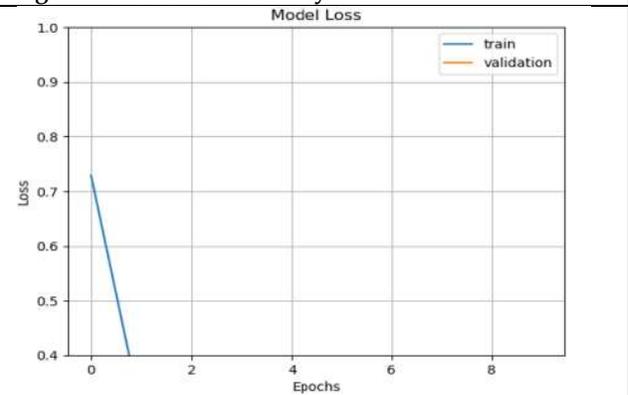
Fig 13. Classification Report of 5L CNN Model

Fig 14. Variation of Loss
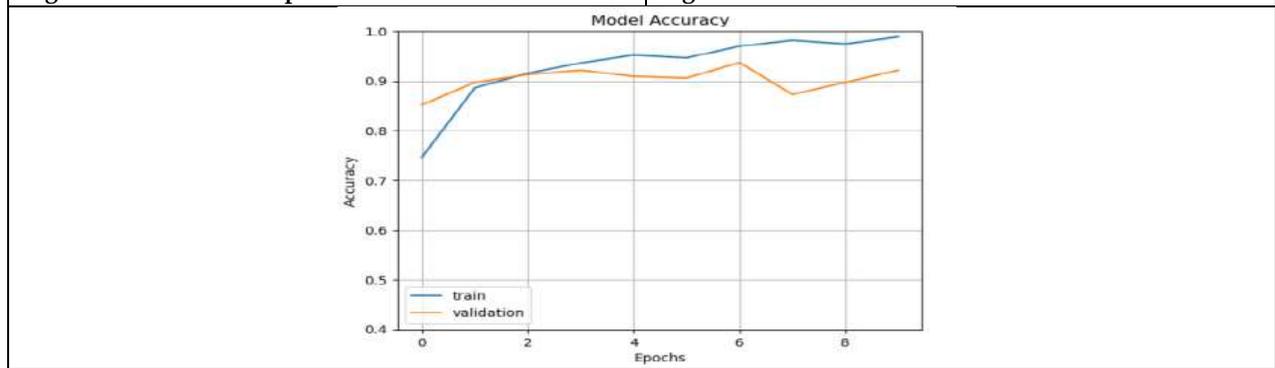
Fig 15. Variation of Accuracy

RESEARCH ARTICLE

Management of Pithapai Kal (Gall Bladder Stone) through Siddha System of Medicine - A Case Report

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ABSTRACT

Cholelithiasis is a typical digestive condition. Bile that has been kept in the gallbladder solidifies into a substance like stone to create gallstones. An excessive amount of bile salts, bilirubin (a bile pigment), or cholesterol can all lead to gallstones. According to age, sex, and regional distribution, cholelithiasis prevalence varies. According to modern research, surgery is the primary method of therapy for this illness. A 29-year-old female patient came to Siddha Hospital with compliments of sudden onset of pain in the right upper quadrant of the abdomen. Along with this pain, moderate back pain, nausea, and vomiting present, bloating stomach, feeling of fullness, and inability to eat fatty food for3 months. Initially she consulted an allopathy hospital and after she had taken a USG abdomen. She had 5-7 stones with the size of 4 – 6mm, She refused surgery and was treated with Siddha medicine for 25days.This case report revealed that the Siddha formulation had a therapeutic effect in the therapy of Cholelithiasis since an Ultra sonogram performed following the Siddha treatment indicated that "No calculus were seen in the gallbladder." The patient's health state significantly improved .

Keywords: Siddha medicine, Pithapaikal , Gall bladder stone

INTRODUCTION

Several bile duct and gallbladder problems are included under gallbladder illnesses. Gallstone production is referred to as cholelithiasis, which may or may not have overt symptoms. Right upper quadrant pain that waxes and wanes, then ceases within a few hours until the next episode, is known as biliary colic and is due to a temporary obstruction of the common bile duct. Cholecystitis is an inflammation of the gallbladder caused by a gallstone obstructing the cystic duct. Once a gallstone reaches the common bile duct, the condition is referred to as choledo cholithiasis. Cholangitis, an inflammation of the bile duct, may arise from this. Gallstone pancreatitis is an inflammation of the pancreas brought on by a gallstone blocking the pancreatic duct. Complicated gallbladder disease refers to acute cholecystitis, choledocholithiasis, cholangitis, and/or gallstone pancreatitis [1]. The causes of gallbladder disease are multi factorial Gallstone development could be influenced by elements that impact hepatic synthesis of cholesterol, gallbladder function (stasis or inflammation), bile acid generation, or intestine absorption of cholesterol and bile acids. Risk factors include both modifiable and non modifiable variables[2].

Cholelithiasis affects 10 to 20% of the global population and has been estimated to affect 2 to 29% of Indians. It is seven times more prevalent in North India. The ratio is 4:1, with women being more impacted than males. Gallstones are reportedly more frequent among forty-year-old, obese, reproductive females. Only surgery, namely gall bladder removal (cholecystectomy), is used to treat cholelithiasis, which impairs protein and fat digestion[3]. The classical texts of Siddha do not specifically mention the illness cholelithiasis. In Siddha, the term "Kaladaippu" refers to a stone that is only spoken in relation to Urinary calculi[4]. Gall bladder stores Pitham, hencethe organ gall bladder is considered as Pittha organ in Siddha , and the stone formed in it can be considered as Pithakaba disease. Siddha medicine has a lot of literature evidence on the medicine for this condition rather than clinical studies. This case study analyzes the treatment of gallstone under Siddha treatment by scientifically [5]. As a result, this case report was taken into consideration in order to describe the potentiality of Siddha medication in the management of cholelithiasis.

Risk factor

Nutritional factors that may increase risk of gallstones include constipation; eating fewer meals per day; low intake of the nutrients folate, magnesium, calcium and vitamin [6] and at least for men, a high intake of carbohydrate, a high glycemic load and high glycemic index diet.[7] Wine and whole-grained bread may decrease the risk of gallstones[8].

Case presentation

A 29 Years old female patient reported to Kongan Siddha clinic , Tanjavore with compliments of pain in right upper quadrant of the abdomen to pain radiating to right sub scapular are since 3 months , feeling of fullness, inability to eat fatty , are associate complients . she consult an Multispecialty Hospital, 4-day history of progressively increasing abdominal pain in the right upper quadrant, associated with vomiting , On Physical examination reveals severe pain at right upper quadrant. Patient was advised to take USG Abdomen, she has 5-7 stones with the size of 4 – 6mm ,They advised for surgery. she refused surgery and came to our clinic and she was treated with Siddha medicine for 25days .

General examination

The general condition of the patient was stable. She had no other associated systemic illnesses. Weight: 56kg; height: 160 cm; body build: normal. Vitals were within the normal limit**.** BP: -110/70 mm Hg**; HR: 85**/min; PR: 83/min; **RR: 20**/min**.**

Physical examination

Per abdomen: Tender, particularly in the upper right quadrant with a positive Murphy's sign.

Diet and lifestyle advice

Gallstone production is influenced by dietary components as well as lifestyle choices. Hence, healthy and regular food was advised which can be digested easily. A low-fat diet was advised to the patient. The patient was advised to eat citrus- flavoured items (such as oranges and lemons).Warm water was also advised for consume.

Follow-up and outcomes

The patient was followed up for 1 month. All symptoms were subsided within 10 days. After 25 days of Siddha treatment, she was advised to go for ultra-sonography, which were compared with that of previous scan reports. In USG scan, no GB stone was identified, and the patient had no symptoms.

DISCUSSION

Gallstones, also known as cholelithiasis, are calcified collections of digestive fluid that can develop in the gallbladder. The gallbladder, a tiny organ, is located directly below the liver, A digestive liquid stored in the gallbladder, flows into the small intestine. Usually, bile contains enough chemicals to break down the cholesterol the liver excretes. However, if the liver excretes more cholesterol than the bile can break down, the extra cholesterol may crystallize and finally solidify into stones.[12] Gallstones are asymptomatic in the majority of cases and affect 6% of men and 9% of women . 1% to 2% of people with asymptomatic gallstones that were unintentionally identified will experience symptoms or consequences each year. In a healthy gallbladder and biliary tree, asymptomatic gallbladder stones do not require treatment unless they cause symptoms.[13][14][15] According to Siddha, Vaatham, Pitham and Kapamall three dhosamplaysa role for the formation of gallstone, excessive increase of Pitham due to spicy food ,alcohol etc. to creates the basic stone formation. An exceptionally sticky combination results when Pittham and Kapham, both aggravated by fatty, heavy diets. This concoction is dried by Vatham, which then shapes it into the form of a stone. Giving Raja peathiennai on empty stomach will balance Thiridhosam and remove the excessive fat in our body.

The Navauppumazhugu and Neermullikasayam are indicated for breaking stone in Siddha classic litraturies. Further, Neermullikasayam is considered as one of the best anti-oxidants, Hypolipidemic activity, Diuretic activity, hepato-protective, and poses anti-inflammatory properties.[16] Karisaalaikarpam has anti-oxidants and hepato protective activity[17] Kadalnooraiparpam(Scraping) will reduce the concentration of bile by reducing mucous hyper secretion and hyper-lipidemia. Motility of the gallbladder is improved due to the Vaatham(Directing Vata in right direction) property. Nvauppumezhugu by its Prabavam, thus dissolves the stone and corrects the metabolic causes and prevent the further formation of Pithapaikal (Cholelithiasis). It significantly decreases TC, TG, and LDL levels while raising HDL levels, facilitating in the dissolution of gall stones caused by cholesterol. Liquefied bile will be filtered and expelled through the urine as a result of the diuretic (lithotriptic) action. Even the patient's overall health and symptoms is gradually becoming better.

CONCLUSION

In this case report, the patient's Cholelithiasis (Pithpaikal) treatment has yielded good outcomes. According to the USG-abdomen, the patient eliminated 4-6mm and 5-7 of gallstones in 25 days by taking Siddha treatment. Furthermore, the patient's general health has significantly improved. There fore, Siddha medicine has the potential to treat cholelithiasis effectively, according to the findings of this case study As a result, those who are affected by the condition should be encouraged to benefit from Siddha medicine and actively contribute to the nation's prosperity by residing enthusiastic lives.

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Informed consent

Informed consent was obtained from the patient before the onset of treatment and for publishing the details obtained from her.

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Table 1 Details of Siddha intervention.[9][10][11]

Medicine	Dosage	Adjuvant	Time of Administration	No. of days taken the medicine
Raja peathiennai	1ml	Ginger juice	Early morning empty stomach	1day
Thangauram	135mg	Palm jaggery	Before food Once a day	24 days
KadalnooraiParpam	200mg	Kovaiillaisaaru	After food twice a day	24 days

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.Navauppumezhugu	500mg	Palm jaggery	Before food Oncein a day	10 days
Karisaalaikarpam	500mg	Luke warm water	After food	24 days
Neermullikudinner	60ml	-	After food twice a day	24 days

Table 2. Results of USG abdomen before and after treatment

USG abdomen	Before treatment (28.12.2022)	After treatment (14.02.2023)
Status of Gall Bladder	Few calculus (5 -7 number) noted in body of GB.each measuring 4-6mm.wall thickness normal	GB appears normal no E/O any calculus is seen at present.

RESEARCH ARTICLE

Biosorption of Chromium (Cr) Heavy Metal using *Prosopis juliflora* Plant Derived Biomass

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ABSTRACT

Heavy metals are the anxiety of the present days. Among the heavy metals, Chromium (VI) is regarded as a highly toxic heavy metal released largely from textiles, tanneries, electroplating and metallurgical industries. To remove such high concentrations of Chromium (VI), an advanced method is essential. Thus, biosorption using plant derived biosorbent, which is an organic material produced from various sources such as *Prosopis juliflora* dried leaf powder, can be applied successfully for Chromium(VI) reduction. The major objectives of this study was the remediation of the Chromium(VI) heavy metal using *Prosopis juliflora* dried leaf powder and determine the effect of initial metal ion concentration, pH, temperature and biomass loading on the percentage removal of Chromium. The optimum initial metal ion concentration, pH, temperature and biomass loading was found to be 50mg/l, 2.0, 30°C and 4g respectively. Remediation of Chromium(VI) using *Prosopis juliflora* dried leaf powder proved to be effective and removed the maximum concentration of Chromium(VI). Hence, the use of plant derived dried *Prosopis juliflora* leaf powder as biosorbent was highly effective as a sorbent, which could effectively be applied to small as well as large-scale levels.

Keywords: Plant derived biosorbent, Chromium, sorption experiments and *Prosopis juliflora*

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INTRODUCTION

Chromium(Cr) is widely used in many chemical and manufacturing industries, leather, electroplating, tanning, medicine and pigment production (Singh *et al.,* 2021). Usually, more than 2.5–3.0 times the amount of Chromium waste is discharged during the generation of Chromium. For historic purposes, Chromium waste has been simply were piled up; therefore, the release of dissolved Chromium causes significant pollution problems for the soil, surface water and groundwater environment. In polluted soils, Chromium exists predominantly in two states: trivalent Chromium(III) and hexavalent chromium Chromium(VI). Chromium(III) has low toxicity, weak mobility, and low bioavailability and is readily sequestered by natural clays or precipitation as $Cr(OH)_3$ (Yang *et al.,* 2021). In contrast, Chromium(VI) exists mainly as $HCrO_4$ and CrO_4 2- oxyanions, which exhibit strong mobility and high bioavailability (Song and Ma, 2017).The toxicity of Chromium(VI) is roughtly 100 times higher than that of Chromium(III) (Choppala *et al.,* 2015). Therefore, Chromium(VI) compounds have been listed as priority pollutants by the Environmental Protection Agency (EPA) due to their mutagenicity, carcinogenicity and teratogenicity to humans (IARC, 2010). The Chromium(VI) content in contaminated soil is generally more than 1000 mg/kg (Wang *et al.,* 2020), approximately 175 – 1000 times higher than the risk screening value (≤5.7 mg/kg) for the soil contamination of land for development land in soil environmental quality standards in China (GB 36600–2018). Therefore, examining suitable alternate economical approaches for the remediation of Chromium(VI)-polluted soil is an urgent task. The main treatment methods for Chromium(VI) polluted soil remediation include chemical reduction (Jiang *et al.,* 2019), chemical washing (Gautam *et al.,* 2020), electro kinetic remediation (Zhou *et al.,* 2018) and Phytoremediation methods (Muthusaravanan *et al.,* 2018).

Chemical reduction primarily converts highly toxic Chromium(VI) into low toxic and it is difficult to migrate Chromium(III) precipitation through chemical reduction reaction, which can effectively decrease the migration ability and bioavailability of Chromium(VI) (Karimi-Maleh *et al.,* 2021). Chemical washing is more suitable for Chromium(VI) polluted soil with large particle size and high coefficient of permeability, such as sandy soil (Wang *et al.,* 2021). For clay soil, the ability of washing agent in soil is restricted, and the maintaining and adsorption capacity of clay for Chromium(VI) is strong, so its elution efficiency is low. Electro kinetic remediation can remove heavy metal rapidly and efficiently in top soil through electro migration and electro osmotic advection controlled by a direct-current electric field (Kirkelund *et al.,* 2019). The disadvantage of electro kinetic remediation is elevated power consumption and high cost. Phytore mediation is another method, in which plants, due to their intrinsic nature, can remove metals from soil and aquatic environment, but this also suffers from adverse effect such as deposition of heavy metals in their tissue as well as their slow rate of growth which limits their uses for the mentioned purposes on large scale. Adsorption has been used as the best methodology since it is inexpensive, eco-sustainable, and has a high rate of elimination. Various number of mineral and organic low-cost adsorbents were reported in literature for the removal of pollutants such as raw and modified clays, tea wastes, coal fish, saw dust, activated carbon, hazel nut shell and olive tree pruning. The adsorption capabilities of the biomass-based adsorbents can more effectively be utilized if the phytore mediation capability of a given plant is evaluated prior to its conversion into a biosorbent.

MATERIALS AND METHODS

Plant derived bio sorbent
The Prosop is juliflora leafs was collected from around Chidambaram Town of Cuddalore District in Tamil Nadu. Leafs were washed, dried and crushed in primary crusher, air dried in sun for several days until its weight remains constant. After drying, it is crushed in roll crusher and hammer mills. The material obtained through crushing and grinding is screened through BSS mesh with a pore size of 75µm. Finally the product obtained is stored in glass bottles for further use.

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Preparation of stock chromium solution
1000 mg/l of stock chromium solution was prepared by dissolving 2.83 g of Potassium dichromate in 1 litre of double distilled water.

Batch biosorption studies
Batch experiments were carried out in Erlenmeyer flasks by adding known amount of *Prosopis juliflora* dried leaf powder in 100 ml aqueous Potassium dichromate solution. The flasks were agitated on a shaker with a constant shaking rate at 150 rpm for 135 min until equilibrium was attained. Samples were taken from the solution at regular time intervals for testing the residual metal ion concentration in the solution. The residual concentration of chromium ions in the solutions was determined spectrophotometrically at 540 nm using Diphenylcarbazide as the colour complexing agent. The effect of initial Chromium ion concentration on percentage removal of Chromium was analyzed by conducting experiments with different initial Chromium ion concentrations namely 50 mg/l, 100 mg/l, 150 mg/l, 200 mg/l and 250 mg/l under identical conditions of temperature (30°C), pH-2 and biomass loading (4g). The effect of initial pH on percentage removal of chromium was studied by conducting experiments at different initial pH namely 2,3,4,5 and 6 under identical conditions of initial Chromium(VI) ion concentration, temperature and biomass loading. The effect of temperature on percentage removal of chromium was studied by conducting experiments at different temperature namely 25°C, 30°C, 35°C and 40°C under identical conditions of initial Chromium(VI) ion concentration, initial pH and biomass loading. The effect of biomass loading on percentage removal of chromium was analyzed by conducting experiments with different biomass load namely 1g/l, 2g/l, 3g/l, 4g/l and 5g/l under identical conditions of initial Chromium(VI) ion concentration, initial pH and temperature.

Percentage removal of chromium

The percentage removal of chromium was calculated by Percentage removal of chromium $= \dfrac{Co - Ct}{Co}$

$$\frac{\text{Initial concentration} - \text{Final concentration}}{\text{initial concentration}} \times 100$$

Where,
C_O = Initial concentration
C_t = Final concentration
Specific uptake of chromium
The specific uptake of chromium was calculated by

Specific uptake $= \dfrac{Co - Ct}{M} \times v$

Where,
C_O = Initial concentration
C_t = Final concentration
M = Mass of bio sorbent
V = Volume of metal solution

RESULT AND DISCUSSION

The biosorption capacity (quantity of biosorbed metal ions per unit weight of the biosorbent) of the biosorbent increases initially with the increase in metal ion concentration and then attains a saturation value. However, the bio sorption efficiency of the bio sorbent reduced with increase in metal ion concentration. The higher bio sorption efficiency at low metal concentration is due to the complete interaction of ions with the available binding which sites results in higher rates of efficiency. At higher concentrations, the number of metal ions remaining unbound in the solution is high due to the saturation of available binding sites (*Naiya et al.*, 2009). In the present study, *Prosopis juliflora* plant leafs was collected from around Chidambaram Town in Cuddalore District of Tamil Nadu. The effect

of initial metal ion concentration on percentage removal of   chromium by *Prosopis juliflora* dried leaf powder was studied and the results were presented in Fig-1. As initial metal ion concentration of chromium increases from 50(mg/l), 100(mg/l), 150(mg/l), 200(mg/l) and 250(mg/l).The percentage removal of chromium reduced with increasing initial metal ion concentration. The highest chromium removal efficiency 93.5% was observed at 50(mg/l), for higher concentrations considerable reductions were found in chromium removal efficiency. The percentage removal of chromium reduced from 93.5 to 87.5%. The effect of initial metal ion concentration on specific uptake of chromium by *Prosopis juliflora* dried leaf powder was examined and the results were presented in Fig-2. As initial metal ion concentration of chromium increases form 50(mg/l), 100(mg/l), 150(mg/l), 200(mg/l) and 250(mg/l) the specific uptake of chromium increases with increasing initial metal ion concentration from 10.5mg/g to 52.5mg/g, suggesting the competing effects between the metal ions for the binding sites in biomass is very strong at the lower concentration 50(mg/l), it is found to be less. At lower concentrations, all metal ions present in the solution would interact with the binding sites and thus allowed 100% adsorption. At higher concentrations, more Cr ions are left unabsorbed in solution due to the saturation of binding sites. This indicates to be due to the increase in the number of ions competing for the available binding sites in the biomass (Puranik and Paknikar, 1999).

pH is an important parameter for adsorption of metal ions from aqueous solution because it affects the solubility of the metal ions, concentration of the counter ions on the functional groups of the adsorbent and the degree of ionization of the adsorbate during reaction. Biomass has active sites capable of binding metal ions. Thus it is regarded as a complex ion exchanger similar to a manufacturing resin. Such bond formation could be followed by displacement of protons and is dependent in part on the extent of protonation which is determined by the pH (Volesky and Holan, 1995). The effect of pH on percentage removal for the sorption of chromium by *Prosopis juliflora* dried leaf powder was examined and the results are given in the Fig-3. The percentage removal of chromium reduced with pH increases from 2.0 to 6.0. The highest percentage removal of chromium was obtained at pH 2.0 as 90.5%. The pH of the medium affects both the solubility of metal ions and ionization of the functional groups which are acidic and carry negative charges rendering cell walls to be potent scavenger of cations (*Prasad et al.,* 2003). At very low pH, the functional groups remain in in protonated form and create less conductive binding charges condition for the bio sorption due to the reduction in negatively charged surface. However, with the increase in pH, the negative charge density on the cell surface increases due to deprotonation of the metal-bindings sites, thus increasing the attraction of metallic ions with positive charge thus accepting the bio sorption on the cell surface (Abdi, 2015). The effect of temperature on percentage removal for the sorption of chromium by *Prosopis juliflora* dried leaf powder was investigated and the results were summarized in Fig-4. It is evident that the percentage removal of chromium increased with increasing the temperature 25ºC to 30ºC.

The highest percentage removal of chromium was recorded at 25ºC as 86.5% further increasing the temperature up to 40ºC, the percentage removal of Chromium decreased. Similarly the results strongly support the view expressed by (*Ahalya et al.,* 2003). (*Goyal et al.,* 2003) reported that the biosorption efficiency remains unaffected within the range 20-35 ºC, although high temperatures, such as 50 ºC, may increase biosorption in some cases, but these high temperatures may cause permanent damage to microbial living cells and then reduce metal uptake. Adsorption reactions are primarily exothermic and the extent of adsorption increases with decreasing temperature. At high temperature, the density of the boundary layer decreased, due to increased tendency of the metal ion to separated from the *Colocasia esculenta* biomass surface to the solution phase, which resulted in a reduce in the adsorption as temperature was increased (Horsfall and Spiff, 2004). The effect of biomass loading on percentage removal for the sorption of Chromium by *Prosopis juliflora* dried leaf powder was examined and the results were presented in Fig-5. The percentage removal of chromium increases from 76.5 to 89.5%. At 4g of *Prosopis juliflora* dried leaf powder biomass loading was obtained the highest percentage removal of chromium 89.5%. There is no significance difference in removal efficiency for increase of 5g of biomass. This increase in sorption efficiency with increase in biomass concentration is indicative of the higher number of binding sites at increased biomass concentration. The lower increment in percentage removal of chromium observed above biomass of Citrus reticulate waste concentration of 1.0 g/L may be attributed to the strong limitations of chromium ions mobility in the bio sorption medium (*Zubair et al.,* 2008).

CONCLUSION

In the present work, *Prosopis juliflora* biomass showed the high removal effiiency of Chromium(VI) at 50(mg/l) initial concetration of chromium, optimum pH-2, temperature 30°C and biomass loading 4g/l were resulted respectively. It can be concluded that *Prosopis juliflora* biomass is promising biosorbent for removal of heavy metals for polluted sites.

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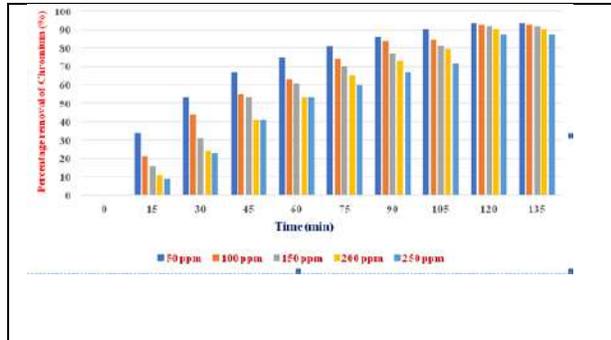
Fig-1 Effect of Initial metal ion concentration on Percentage removal for the sorption of chromium by dried *Prosopis juliflora* leaf powder.	**Fig-2 Effect of Initial metal ion concentration on specific uptake of chromium by dried *Prosopis juliflora* leaf powder.**
Fig-3 Effect of pH on Percentage Removal of Chromium by dried *Prosopis juliflora* leaf powder.	**Fig-4 Effect of temperature on Percentage removal for the sorption of chromium by dried *Prosopis juliflora* leaf powder**
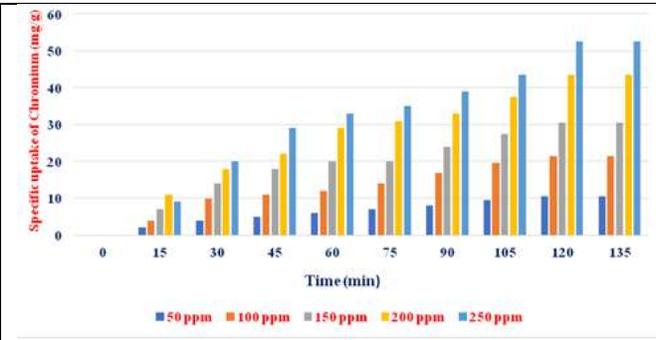
Fig-5 Effect of Biomass Loading on Percentage Removal for thesorption of chromium by dried *Prosopis juliflora* leaf powder.

RESEARCH ARTICLE

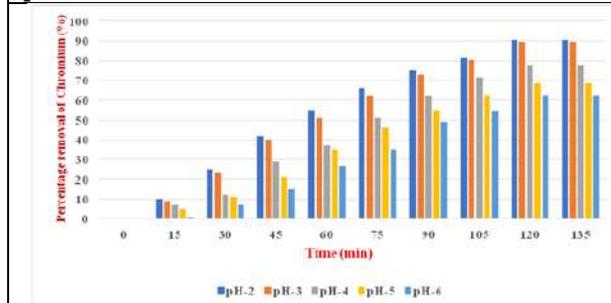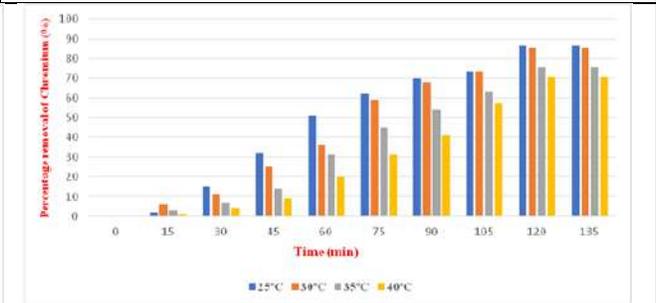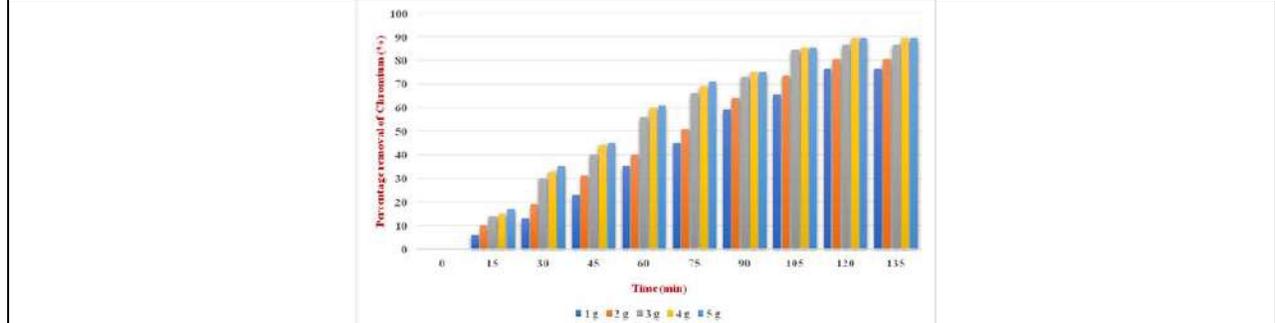# Metabolite Profiling by GC-MS Analysis and Evaluating the Cytotoxic Potential of *Phyllanthus reticulatus* Poir.

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ABSTRACT

Phyllanthus reticulatus Poir. is well known for its significance in traditional medicine all over the world. It has a variety of traditional uses and is used for treating diabetes, bleeding gums, and digestive disorders. Additionally, it is applied topically as a poultice for skin ulcers, sores, and swellings. Present study provides an overview of the phytochemistry and cytotoxicity of *Phyllanthus reticulatus.* Preliminary analysis with methanol, chloroform and petroleum ether extracts showed the presence of terpenoids, flavonoids, steroids, coumarins, phenols, flavonoids, and alkaloids. GC-MS analysis of methanol extract showed the presence of an array of 22 biologically active components with a wide range of therapeutic properties. The MTT assay was used to examine the cytotoxic effects of *Phyllanthus reticulates* on colon cancer cell line HT-29. It showed an IC_{50} value of 69.65 µg/ml which measures the acute toxicity of plant extract for colon cancer cells. This may be due to the presence of anticancer components in *Phyllanthus reticulatus..* Present study thus shows that *Phyllanthus reticulates* can unquestionably be a promising candidate in the search for plants that have anticancer properties. However, more studies are necessary to understand its mode of action and its effect on different tissue sites.

Keywords: *Phyllanthus reticulatus,*Preliminary phytochemical analysis, GC-MS analysis, Cytotoxicity, HT-29 cell line

INTRODUCTION

Plants are a vital source of food, fibre, medicine, and other essentials. Traditional plant based medicine is the primary source of healthcare for more than 80% of the world's population. Due to their potential for use in both science and medicine, herbal remedies are gaining popularity. Herbal treatments are often made up of mixtures of various plant parts, which might improve their medicinal effects. Herbal formulations effectiveness is based on the presence of phytochemical components [1]. A therapeutic plant's medical effectiveness depends on its phytoconstituents, which can work singly or in combination. Alkaloids, flavonoids, phenolics, tannins, saponins, steroids, glycosides, terpenes, and other important phytochemicals all have unique functional qualities [2]. Phytochemicals have multiple functions in plants, such as disease defence, flavour, colour, and aroma enhancement, as well as protection against pathogens, pollutants, stress, drought, and UV rays. Based on their protective role as well as their physical and chemical properties, more than 4,000 phytochemicals have been identified and categorised [3]. Studies have demonstrated the therapeutic benefits of these phytochemicals for a wide range of illnesses, from critical problems like cancer to common coldand emphasises the preventative effects of phytochemicals against chronic diseases [4]. GC coupled to MS is a highly effective technique and a preferred method for analysing small and volatile molecules. It is extremely useful for determining unidentified chemicals and evaluating multi-component systems [5].

By analysing the spectra and comparing them to reference spectra, GC can identify new chemical compounds in complicated combinations [6]. While GC can distinguish between volatile and semi-volatile substances with great resolution, it cannot identify them. However, MS can provide thorough structural details, enabling accurate identification and quantification of the majority of substances [7]. Cancer is a leading cause of death globally, resulting in nearly 10 million deaths annually. Despite efforts to combat the disease, it remains a significant problem, necessitating the development of effective treatments. While innovative synthetic chemotherapeutic drugs have been created, their high cost and limited success in recent years have generated a demand for potent new anticancer medications. Natural products derived from plants have emerged as promising agents for cancer prevention and treatment, as they have demonstrated potential for inhibiting carcinogenesis and related inflammatory processes. The plant kingdom has been a valuable source of cancer drugs, including Podophyllumlignans, Camptotheca alkaloids, Taxusditerpenes, and Vinca alkaloids [8]. Cytotoxicity studies are essential for evaluating the safety of drugs and other substances that come into contact with human cells, which makes them important in drug development and toxicity evaluation. Various methods, such as cell viability assays, flow cytometry, and microscopy, are used to perform cytotoxicity assays. Cell lines derived from single cells are widely used in cancer research and drug development due to their uniform gene responses.

Cancer cell lines serve as valuable in vitro model systems and represent a rich and consistent source of biological material for experimental purposes [9]. *Phyllanthus*, a genus in the Phyllanthaceae family, includes shrubs and trees with an array of applications in pharmacognosy, medicinal chemistry, and economic botany. The genus has garnered significant attention for its anti-HIV, anticancer, and anti-HBV properties, leading to in depth research on its pharmacology and chemistry. In India, fifteen species of *Phyllanthus* are commonly used in traditional medicine. They are also known for their bitter and astringent taste and various medicinal benefits [10]. *Phyllanthus reticulates* Poir.in particular, serves multiple purposes, ranging from food to medicine [11]. Different parts of this plant have traditionally been used to treat a variety of health conditions, including urinary infections, bleeding gums, malaria, and digestive disorders. The *Phyllanthus reticulates* leaves and roots are used to cure fractures, diabetes, and have diuretic and antibacterial effects [12]. Notably, P. *reticulatus* extract has demonstrated anti-proliferative, apoptotic, and anti-migratory actions; these effects are essentially explained by the extract's capacity to cause apoptosis in cancer cells [13]. Taking all these aspects into consideration preliminary phytochemical analysis using different extracts of *Phyllanthus reticulates* was conducted followed by the GC-MS analysis for identifying volatile phytochemical constituents of the methanol extract of the plant. Screening of the cytotoxic activity of extract of

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Phylanthus reticulates against colon cancer HT-29 cell line was also performed to elucidate its anti-proliferative property.

MATERIALS AND METHODS

In the present study, phytochemical profiling was carried out by qualitative and GC-MS techniques whereas bioactivity screening mainly emphasized on cytotoxic studies with HT - 29 cell line. *Phyllanthus reticulatus* Poir. was collected at flowering and fruiting stage from Kanjirapuzha region of Palakkad District, Kerala. The aerial parts of healthy plants were collected and brought to the laboratory for subsequent processing. Leaves and stem were separated and shade dried at room temperature for 2-3 weeks. The dried material was made into fine powder and stored in air tight containers. Dried powder (50 g) was extracted with three different solvents - methanol, chloroform and petroleum ether in a soxhlet device for 6–8 hours. The resulting extracts were then filtered, cooled, and concentrated to remove solvent in a rotary evaporator and were kept at 4 °C in amber-coloured glass vials for further studies.

Preliminary Phytochemical Analysis

Methanol, chloroform and petroleum ether extracts of *Phyllanthus reticulatus* were subjected to different chemical tests for the detection of different phytoconstituents using standard procedures [14, 15].

1. Dragendroff's test for alkaloids: Combining 1 ml of sample solution with Dragendroff reagent (potassium bismuth iodide) in a test tube forms an orange-red precipitate if alkaloids are present.
2. Test for phenols: Treating 1 ml of the extract with 5% ferric chloride results in a dark green/brown precipitate, indicating the presence of phenols.
3. Steroid and terpenoid test: Mixing 1 ml of the sample solution with chloroform, followed by a few drops of concentrated sulphuric acid, leads to a reddish-brown color at the interphase if steroids and terpenoids are present.
4. Flavonoid test: NaOH test: Adding 3 ml of diluted NaOH to 1 ml of the sample solution produces a yellow precipitate, disappearing upon addition of diluted HCl, confirming the presence of flavonoids. Lead acetate test: Combining 1 ml of lead acetate solution with the sample solution results in a white turbid precipitate, indicating the presence of flavonoids.
5. Coumarin test: Adding 1 ml of sample to 1 ml of $FeCl_3$ in a test tube reveals a dark green tint, changing to yellow upon addition of five drops of concentrated HNO_3, indicating the presence of coumarins.
6. Cardiac glycoside test (Keller-Killani test): Mixing 2 ml of acetic acid, 1 ml of concentrated H_2SO_4, 1 drop of $FeCl_3$ solution, and 5 ml of extract in a test tube forms a brown ring if cardiac glycosides are present.
7. Tannin test: Lead acetate test: Adding a few drops of 10% lead acetate to 2 ml of the sample results in the formation of a white precipitate, indicating the presence of tannins.Potassium dichromate test: Adding a few drops of the sample to a strong solution of potassium dichromate produces yellow precipitates, confirming the presence of tannins.
8. Saponin test (froth test): Mixing 2 ml of distilled water with 1 ml of the sample solution in a test tube and shaking the mixture creates froth if saponins are present.
9. Quinone test: Treating a small amount of the extract with strong HCl leads to the formation of a yellow colour precipitate, indicating the presence of quinones.

Gas Chromatography-Mass Spectrometry (GC-MS) analysis

The volatile compounds in *Phyllanthus reticulates* methanol extract were identified and measured using GC-MS. The GC-MS analysis was performed using a Shimadzu QP-2010 Plus with a Thermal Desorption System TD 20. It has a 60 m x 0.25 mm x 0.25 m diethylene glycol-coated WCOT column (AB-Innowax 7031428, Japan). Helium served as the carrier gas, flowing at a rate of 1.21 ml/min and with a 77.6 kPa column pressure. Temperatures of 260°C were chosen for the injector and detector. Sample (8 μl) was injected into the column at a split ratio of 10:0. Component separation was achieved using a linear temperature programme that ran from 70°C to 260°C for a total of 65.32 minutes. At a voltage of 70 eV for electron ionisation (EI), the mass range was 40-700 m/z, the detection voltage was

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1.5 V, and the peak width was 2s. The constituents were identified by comparing the linear retention indices, MS fragmentation patterns, and mass spectra libraries from the National Institute of Standards and Technology (NIST) and Wiley to those of other compounds with known compositions. They were then quantified using their GC peak regions, and the result was expressed as a percentage.

Cytotoxic evaluation using MTT assay on HT- 29 cell line

HT-29 (Human colon cancer) cell line procured from National Centre for Cell Science (NCCS), Pune, India and maintained in Dulbecco's modified Eagle's medium, DMEM (Sigma Aldrich, USA) was cultured in 25 cm^2 tissue culture flask with DMEM supplemented with 10% FBS, L-glutamine, sodium bicarbonate (Merck, Germany) and antibiotic solution containing: Penicillin (100μg/ml), Streptomycin (100μg/ml), and Amphotericin B (2.5μg/ml). It was kept at 37ºC in a humidified 5% CO_2 incubator (NBS Eppendorf, Germany). The viability of cells were evaluated by direct observation of cells by Inverted phase contrast microscope followed by MTT assay method.

Cells seeding in 96 well plate

Two days old confluent monolayer of cells were trypsinized and then the cells were suspended in 10% growth medium. Cell suspension (100μl, 5x103 cells/well) was seeded in 96 well tissue culture plate. It was incubated at 37ºC in a humidified 5% CO_2 incubator. Compound stock was prepared with 1mg of sample, weighed and dissolved in 1ml 0.1% DMSO using a cyclomixer. The sample solution was filtered with 0.22 μm Millipore syringe filter to ensure sterility.

Anticancer Evaluation

The growth medium was removed after 24 hrs., freshly prepared each compounds in 5% DMEM were serially diluted five times by two fold dilution (100μg, 50μg, 25μg, 12.5μg, 6.25μg in 500μl of 5% DMEM) and each concentration of 100μl were added in triplicates to the respective wells and incubated at 37ºC in a humidified 5% CO_2 incubator. Non treated cells were also maintained as control.

Anticancer Assay by Direct Microscopic observation

Entire plate was observed after 24 hours of treatment in an inverted phase contrast tissue culture microscope (Olympus CKX41 with Optika Pro5 CCD camera)**.**Detectable changes in themorphology of the cells indicating cytotoxicity were noted.

Anticancer Assay by MTT Assay

Fifteen mg of MTT (Sigma, M-5655) was reconstituted in 3 ml PBS until completely dissolved and sterilized by filter sterilization. After incubation period (24 hours), the sample content in wells were removed and 30μl of reconstituted MTT solution was added to all test and control wells, the plate was gently shaken and incubated at 37ºC in a humidified 5% CO_2 incubator for 4 hours. After the incubation period, the supernatant was removed and 100μl of MTT solubilisation solution (DMSO, Sigma Aldrich, USA) was added and the wells were mixed by pipetting up and down in order to solubilize the formazan crystals. The absorbance values were measured by using a microplate reader at the wavelength of 540 nm [16]. The percentage of growth inhibition was calculated using the formula:

% of viability $= \frac{\text{Mean OD Samples}}{\text{Mean OD of control group}} \times 100$

Statistical analysis

Experimental results are expressed as Mean ± SEM. All experiments were replicated three times. The IC_{50} values were calculated from linear regression analysis.

RESULT AND DISCUSSION

The major objective of the present study was to identify the phytochemicals present in the extract through preliminary phytochemical screening as well as to identify volatile components by GC-MS followed by evaluation of cytotoxic potential of *Phyllanthus reticulates* Poir. The initial phytochemical screening was conducted with methanol, chloroform and petroleum ether extracts. The results obtained are summarised under the following subtitles.

Preliminary phytochemical analysis
Medicinal properties of plants may be attributed to the phytochemical compounds in them with properties such as antioxidant activity, antimicrobial effect, anti-cancer properties, etc. In this study, qualitative phytochemical analysis was conducted with methanol, chloroform and petroleum ether extracts of *Phyllanthus reticulatus.*. The observations are summarized in Table 1. The methanol extract of the plant showed the presence of alkaloids, phenol, steroid, terpenoid, coumarins and quinones. Also, the results were positive for flavonoids and tannins in the lead acetate test. The chloroform extract gave results for alkaloids, phenol, steroids, terpenoid and flavonoids. The petroleum ether extract showed the presence of alkaloids, phenol, steroids, terpenoids, coumarins and quinones whereas, tannins gave positive results in the lead acetate test only. Functional bioactive substances of plant origin have been a valuable source for numerous therapeutic medications for humans and have been crucial in the management of numerous diseases all over the world. These substances have a huge variety of chemical and structural properties contributing to their bioactive potential[17]. Presence of a variety of phytocomponents in preliminary analysis is an indication of the therapeutic potential of plant under study. Since methanol extract of *Phyllanthus reticulatus* showed more class of compounds in preliminary screening, this extract alone was considered for further studies.

GC-MS analysis
Gas chromatography-mass spectrometry (GC-MS), is a hybrid analytical technique that combines the separation powers of GC with the detection features of MS. While a sample's volatile components can be separated by GC, MS help to fragment the components and identify them based on their mass. With the improved sample identification and better sensitivity, GC-MS is applicable in a variety of different contexts. The extract in methanol was chosen as a solvent for GC-MS analysis since early phytochemical testing indicated that it contained a higher amount of phytochemicals. Because of its polarity, methanol is a perfect solvent. It can draw molecules from plant components, both hydrophilic and lipophilic. As methanol is quite volatile, we can distil the solvent after extraction at a low temperature to eliminate it. In the present study of GC-MS analysis with methanol extract of *Phyllanthus reticulatus,*the results revealed the presence of 22 different phytoconstituents with various retention times (Table 2). Phytol was the main component followed by Dehydrovomifoliol. Octacosanol, γ-sitosterol, Phytyl palmitate and Henicosanol were found as the remaining major components in *Phyllanthus reticulatus.*.

Phytol and its derivatives have shown a variety of properties including cytotoxic, anti-inflammatory, anti-diabetic, anti-hyperalgesic, antimicrobial, anti-tumour, antifungal and antispasmodic activity [18].The primary monoterpenoids discovered using GC-MS analysis were dehydrovomifoliol. In general, monoterpenoids have a distinctive taste and odour, and they have been utilised as food additives, insecticides, insect repellents, and has immense therapeutic potential[19]. Fatty acid and fatty alcohols were the predominant class of compounds identified followed by terpenoids, steroids and alkane. Palmitic acid , Linoleic acid methyl ester, Oleic acid methyl ester, Methyl stearate, Behenic acid methyl ester, and Methyl lignocerate were the predominant fatty acid compounds and 1-Heneicosanol, 1-Heptacosanol, Henicosanal,Octacosanol,1-Triacontanol derivative were the respective fatty alcohols identified. Neophytadiene, palmitic acid, linoleic acid, oleic acid, phytol, methyl stearate, 1-hepatacosanol, docosanoic acid, squalene, vitamin E, henicosanol, octacosanol, gamma sitosterol and phytyl palmitate identified have displayed sufficient level of anticancer activity in many studies. These phytochemicals often act via regulating molecular pathways which are implicated in growth and progression of cancer. The underlying processes include boosting antioxidant status, neutralising carcinogens, reducing proliferation, inducing cell cycle arrest and apoptosis,

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and immune system control[20]. Figure 1 summarizes the peak of volatile compounds identified in the methanol extract of *Phyllanthus reticulatus*. Safer medications for cancer could be developed using bioactive plant compounds and formulations. Even though, numerous plants and phytochemicals have been explored for this purpose, only a few of them have made it to the point of clinical trial. Therefore, the efficiency and toxicological evidence of the *Phyllanthus reticulatus* anticancer phytochemicals necessitate further clinical research. They must be produced in forms with sufficient bioactivity and bioavailability. Since GC-MS analysis identified numerous possible anticancer phytocomponents in *Phyllanthus reticulatus*, methanol extract of the plant was subjected to cytotoxicity studies with HT-29 human colon cancer cell line.

Cytotoxicity studies using MTT assay on HT- 29 cell line

Cytotoxicity activity of *Phyllanthus reticulatus* extract was tested against HT -29 human colon cancer cell line at different concentrations to determine the IC_{50} by MTT assay. Results of different concentrations of *Phyllanthus reticulaues* extract (6.25, 12.5,25,50,100 μg/ml) are graphically represented in Figure 2. The MTT assay of *Phyllanthus reticulatus* showed significant effect on Colon HT-29 cells (Fig. 3). The percentage of cell viability decreases with increasing concentration of test compounds and IC_{50} value was found to be 69.65 μg/ml. The study thus confirmed that *Phyllanthus reticulatus* has potential anticancer activity in terms of cytotoxicity towards colorectal cell line.Many species of Phyllanthus are known to have anticancer properties. *Phyllanthus amarus* is reported to have immunomodulatory and anticancer efficacy [21]. *Phyllanthus emblica* is also known topossess anticancer and cancer-preventive qualities. The anticancer action of *Phyllanthusemblica* has been attributed to its antioxidant function, but undoubtedly other pathways play an equally significant role [22, 23]. Compounds derived from *Phyllanthus niruri* have demonstrated significant cytotoxicity, anticancer and chemomodulatory effects [24]. *Phyllanthus reticulates* is also reported to have a wide range of pharmacological properties, including anticancer properties [25, 26].These properties elucidated by different species of Phyllanthus can be attributed to the diverse combinations of phytochemicals in them. However, only further screening and research alone can reveal the components responsible for the cytotoxicity and the mechanism behind the activity. Present study evidently shows that *Phyllanthus reticulatus* can be a prospective candidate in the screening of anticancer compounds. However in-depth studies are required to identify the active components responsible for the activity and their mechanism of action should be thoroughly explored. Large clinical trials are recommended to unveil the potential of *Phyllanthus reticulatus* and its constituent's enormous ability for treating and preventing various ailments including cancer.

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Table 1: Preliminary phytochemical analysis of different extracts of *Phyllanthus reticulatus.*

Chemical Constituent	Chemical test	Methanol extract	Chloroform extract	Petroleum ether
Alkaloid	Dragendroff's test	+	+	+
Phenol	Ferric chloride test	+	+	+
Steroids &Terpenoids	Salkowski test	+	+	+
Flavonoids	NaOH test	-	+	-
	Lead acetate test	+	+	-
Coumarins	Ferric chloride test	+	-	-
Cardiac glycosides	Keller killani test	-	-	-
Tannins	Potassium dichromate test	-	-	-
	Lead acetate test	+	-	+
Saponins	Froth test	-	-	-
Quinones	Quinones test	+	-	+

Table 2: Volatile compounds identified by GC-MS analysis in *Phyllanthus reticulatus.*

Peak	R time	Area	Area%	Name	Class
1	11.883	92415	0.57	Heptadecane	Alkane
2	14.346	1683719	10.50	Dehydrovomifoliol	Monoterpenoid
3	14.514	443234	2.76	Neophytadiene	Sesquiterpenoid
4	15.451	618878	3.86	Palmitic acid	Fatty acid
5	17.084	188274	1.17	Linoleic acid, methyl ester	Unsaturated fatty acid
6	17.143	897883	5.60	Oleic acid, methyl ester	Fatty acid
7	17.245	2787457	17.39	Phytol	Diterpenoid
8	17.375	326076	2.03	Methyl stearate	Fatty acid esters
9	18.854	242114	1.51	1-Heneicosanol	Fatty alcohol
10	20.534	251727	1.57	1-Heptacosanol	Fatty alcohol
11	20.778	132299	0.82	Behenic acid, methyl ester	Fatty acid
12	22.045	182921	1.14	Phytane	Isoprenoid alkane
13	22.299	117839	0.73	Methyl lignocerate	Fatty acid ester
14	22.964	149611	0.93	Squalene	Triterpenoid
15	26.253	170444	1.06	Stigmasta-3,5-diene	Sterol lipids
16	26.733	310448	1.93	Vitamin E	Tocochromanol
17	28.692	1100551	6.86	Henicosanol	Fatty alcohol
18	29.001	905901	5.65	Stigmasterol	Steroid
19	30.046	1577406	9.84	Octacosanol	Fatty alcohol
20	30.253	2344302	14.62	gamma.-Sitosterol	Phytosterol
21	30.543	374196	2.33	1-Triacontanol, derivative	Fatty alcohol
22	36.984	1126620	7.03	Phytyl palmitate	Phytol ester of fatty acid

Fig. 1: Gas chromatogram of methanolic extract of *Phyllanthus reticulatus*.

Fig. 2: Evaluation of cytotoxic potential of methanolic extract of *Phyllanthus reticulatus* on HT-29 cells using MTT assay

Fig. 3: Cytotoxic effect of methanolic extract of *Phyllanthus reticulatus* on HT-29 cell line (A). Control (B).6.25µg/mL (C).12.5 µg/mL (D).25 µg/mL (E).50µg/mL (F).100µg/mL

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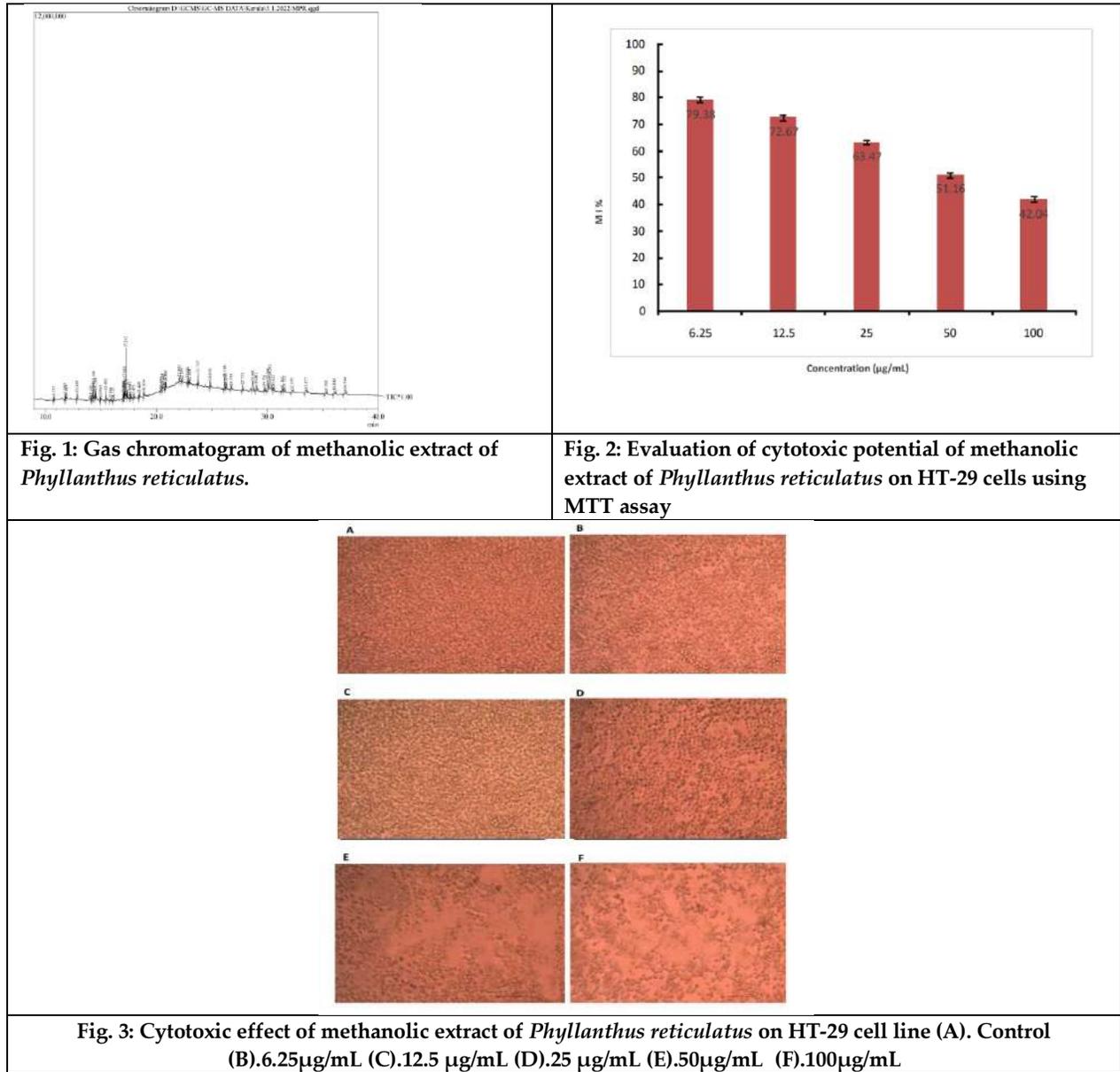
An Air Compressor Failure Detection through Time Series Data using CNN in Deep Learning

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ABSTRACT

Air compressors are critical components in various industrial applications, and their reliable operation is vital for maintaining productivity and preventing costly downtime. Timely detection of compressor failures can significantly reduce maintenance costs and prevent potential hazards. In this study, we propose a novel approach for air compressor failure detection using time series data and Convolutional Neural Networks (CNNs) in deep learning. We collected time series data from multiple sensors installed on an air compressor system, including pressure, temperature, and vibration readings. The dataset was carefully labeled with normal operation periods and various failure scenarios, encompassing different types of mechanical and operational faults. To facilitate the CNN's processing capabilities, we converted the time series data into grayscale images using the Gramian Angular Field (GAF) transformation. For the CNN model design, we employed a customized architecture, leveraging convolution layers, pooling layers, and fully connected layers. Hyperparameters, such as the number of filters, kernel size, and learning rate, were fine-tuned through validation to optimize the model's performance. Data augmentation techniques were utilized to enhance the generalization capability of the model and mitigate over fitting. The proposed CNN-based approach achieved promising results in detecting air compressor failures. Our model exhibited high accuracy in distinguishing normal operation from various failure patterns. Furthermore, the model demonstrated robustness when exposed to unseen test data, indicating its potential for real-world deployment. This research contributes to the field of predictive maintenance for industrial systems by presenting a data-driven approach to air compressor failure

detection. The application of CNNs to process time series data as images proved to be an effective way to capture the underlying patterns associated with impending failures. This study's findings pave the way for developing intelligent condition monitoring systems that can preemptively identify air compressor faults, leading to improved maintenance strategies and reduced operational disruptions.

Keywords: CNN, Air compressor, GAF

INTRODUCTION

Air compressors are widely used in various industrial processes to generate compressed air, serving critical functions such as power tools operation, pneumatic machinery, and HVAC systems. These mechanical devices play a pivotal role in maintaining productivity and efficiency across a spectrum of industries. However, their complex nature and continuous operation make them susceptible to various failures, which can lead to significant economic losses, production downtime, and safety hazards. Traditional methods for monitoring air compressors often rely on rule-based systems and statistical analyses of sensor readings. While these approaches have been effective to some extent, they often lack the ability to capture intricate patterns and subtle anomalies in time series data. Moreover, they struggle to generalize well across diverse failure scenarios, hindering their capability to detect previously unseen faults. With the rapid advancements in deep learning techniques, Convolutional Neural Networks (CNNs) have emerged as powerful tools for pattern recognition tasks, particularly in the realm of computer vision. However, their application to time series data is relatively less explored, presenting a unique opportunity to harness the potential of CNNs for air compressor failure detection.

In this research, we propose a novel approach that leverages the capabilities of CNNs in deep learning to detect air compressor failures using time series data. By converting time series sensor readings into grayscale images through the Gramian Angular Field (GAF) transformation, we enable CNNs to process the data as images. This conversion facilitates the utilization of CNNs' hierarchical feature extraction and pattern recognition abilities, allowing them to discern intricate temporal patterns associated with various failure modes. The objectives of this study are twofold: Firstly, to explore the viability of using CNNs for air compressor failure detection, and secondly, to demonstrate the effectiveness of time series data representation as images through the GAF transformation. By achieving these goals, we aim to contribute to the growing body of research in predictive maintenance for industrial systems.

The remainder of this paper is organized as follows: Section 2 provides a detailed information about Anomaly Approach for Detecting Failures. Section 3 explains failure detection methods using time series data. Section 4 presents the methodology, detailing the dataset, preprocessing steps, CNN architecture, and training procedures. Finally, Section 5 concludes the research paper. In conclusion, this research aims to establish a novel and data-driven approach for air compressor failure detection by combining time series data with CNNs in deep learning. The potential implications of our work include improved maintenance strategies, enhanced safety measures, and increased operational efficiency across industries that rely on air compressor systems.

Anomaly Approach for Detecting Failures

Everything on earth is a signal source. Humans have continuously measured and collected naturally occurring signals such as temperature, wind speed, precipitation, and sunspot intensity to adapt to their environment. Furthermore, in most industries, such as economics (such as sales and market trends), finance (such as stock prices), biomedical (such as heart and brain activity), and manufacturing (such as yield), a large number of different industrial activities have taken place over decades. data has been generated). Across industries, data owners actively collect and use data to improve products, processes, services. Especially with the advent of Industry 4.0, industries have started to intensively use large numbers of sensors to monitor assets and systems simultaneously, leading to increased efficiency and safety [Assendorp J.P *et al*, 2017]. Among various types of data, time-series data has long

been studied in academic fields such as medicine, meteorology, and economics, and is now an essential subject of analysis in most practices. Time series analysis refers to a series of tasks aimed at extracting meaningful information from time series data. The knowledge gained can be used not only to diagnose past behavior, but also to predict the future. Well-known examples of time series analysis include classification, clustering, forecasting, and anomaly detection.

Anomaly detection, the process of identifying unexpected elements or events in data, has become an area of interest for many researchers and professionals, and is now one of the major tasks in data mining and quality assurance. [Blázquez-García A *et al*, 2020]. It has been researched and made great progress in various application fields. Classical methods such as linear model-based methods [Shyu M.L *et al*, 2003], distance-based methods [Angiulli F, 2002], density-based methods [Breunig M.M, 2002], and support vector machines [Scholkopf B, 2001] are still viable choices for algorithms. However, as target systems grow larger and more complex, these methods encounter limitations. This means the inability to work with multidimensional data or deal with the lack of labeled anomalies. In particular, detecting anomalies in time-series data is a challenge because it requires considering together the order and causality between observations along the time axis. Recently, many approaches have been developed to address these challenges. For example, Hu *et al*. [Hu M, 2019] proposed a new computational method using the regression plot (RP), which is a square matrix consisting of time repeating states of a dynamic system. They measure the local recurrence rate (LREC) by scanning the RP using a sliding window and detect abnormalities by comparing the similarity between the LREC curve statistics.

Deep learning, a sub-field of machine learning algorithms inspired by the structure and function of the brain, has gained a lot of attention in recent years. Deep His learning method learns about the complex dynamics of data without assuming the underlying patterns of the data. This property makes it the most attractive choice for time series analysis today. For example, Yang *et al*. [Yan K, 2019] proposed combining an ensemble long short-term memory (LSTM) neural network that stores long-term patterns in time series with the stationary wavelet transform (SWT) to predict energy expenditure. Their experimental results showed that the proposed deep learning method outperforms classical computational methods.   The purpose of this study is to validate state-of-the-art deep learning-based anomaly detection methods for time series data. To our knowledge, previous reviews on this topic [Assendorp J.P *et al*, 2017], [Blazquez-García A, 2020] are limited to a mere classification of models based on descriptions of mechanisms and their properties. In this article, anomalies are discussed and the air compressor time series datasets are the input for the proposed autoencoder approach. The result of the auto encoder approach were processed in to the unsupervised learning to get the better result to predict the Air Compressor information. Hawkins [Hawkins D.M, 1980] described outliers as observations suspected to be generated by different mechanisms because they differ significantly from other observations. In this context, anomalies in time series data can be described as data points within time steps that appear unexpectedly. Significantly different behavior from previous timesteps. Table 1, demonstrates the different forms of anomaly patterns. Following previous studies in the literature, we classify the types of anomalies associated with time series data as follows:

 Abnormal points - A point anomaly is a data point or sequence that suddenly deviates from the norm. Such anomalies appear as transient noise and are often caused by sensor errors or abnormal system behavior. For detection, operators conventionally set upper and lower control limits, commonly referred to as UCL and LCL, respectively, based on previous data. Values outside these limits are considered point anomalies.
Abnormal context Similar to point anomalies, contextual anomalies represent data points or series of data observed over a short period of time, but do not deviate from the normal range in the same way as predefined anomalies bounded by UCL and LCL. is not. However, given the context, the data points are out of range. Expected pattern or shape. Because of this, it can be difficult to detect these anomalies.
Collective anomalies This type of anomaly refers to a set of data points that are considered anomalous because they exhibit changes over time. Individual values within this type of anomaly may seem harmless, but the whole is suspicious. Long-term context is especially important to recognize because they are not immediately recognizable.
Other types of anomalies An anomaly is anything outside of normal, so what is abnormal depends on what you

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define as normal. In general, anomalies can be categorized into one of the three types above, but there are other aspects that can categorize anomalies into more specific categories. In Table 1, Classification and examples of anomalous patterns described in [Bao Y *et al* , 2019].

In summary, an anomaly is a data point that was either very rare or logically impossible to occur in the past. However, multivariate time series data may not classify anomalies as in the previous example. Multivariate time series data require additional considerations and relationships between variables along the time axis. As the number of variables increases, more diverse patterns emerge. In that case, the anomaly pattern may be irregular and the difference between normal and abnormal conditions may not be clear. In that case, the anomaly pattern may be irregular and the difference between normal and abnormal conditions may not be clear. Scanning and aggregating individual univariate time series data to identify anomalies does not guarantee the accuracy of the detection results. This is because only a few anomalous points are masked by other healthy variables and can have a significant impact on the entire target system. The problems can be by extracting unique variables or features to reduce dimensionality, or by using models complex enough to recognize different patterns. Following section is demonstrates how anomaly detection could be done by the CNN approach and the KDCCA.

Failure Detection Methods Using Time Series
A comprehensive review of related literature on failure detection methods using time series data reveals a diverse array of approaches and techniques employed across various industries. Here, the paperpresent a condensed overview of some prominent methodologies, highlighting their strengths and limitations:

Statistical Methods
Statistical methods have been extensively used for failure detection in time series data. Techniques such as mean, median, standard deviation, and trend analysis have proven useful in identifying abnormal patterns and deviations from the expected behavior. While simple and interpretable, statistical methods may struggle to capture complex and subtle anomalies, limiting their effectiveness in handling highly dynamic systems.

Time Series Decomposition
Time series decomposition techniques, like Seasonal and Trend decomposition using LOESS (STL), decompose time series data into its underlying components: trend, seasonal, and remainder. By focusing on the remainder component, anomalies can be detected. While useful for detecting repetitive failures, they may not perform well for detecting sudden or abrupt changes.

Autoregressive Integrated Moving Average (ARIMA)
ARIMA models are widely used for time series forecasting but can also be employed for anomaly detection. These models consider the time dependencies and seasonality in the data. However, they may struggle with capturing non-linear patterns and may require fine-tuning of hyperparameters for optimal performance.

Support Vector Machines (SVM)
SVM has been applied to time series data by converting time series into feature vectors through techniques like Dynamic Time Warping (DTW). SVM can be effective when the data has clear boundaries between normal and abnormal behavior. However, SVM's performance may degrade when dealing with high-dimensional time series data.

One-Class Support Vector Machines (OCSVM)
 OCSVM is a variant of SVM used for unsupervised anomaly detection. It is trained on only normal instances and identifies anomalies as data points lying outside the learned boundaries. OCSVM is useful when labeled failure data is scarce, but it may struggle with complex and multi-modal anomalies.

Neural Networks

Recurrent Neural Networks (RNNs) and Long Short-Term Memory (LSTM) networks have been successfully applied to time series data for anomaly detection. RNNs and LSTMs can capture long-term dependencies, making them suitable for sequential data. However, training deep neural networks may require large amounts of labeled data and can be computationally expensive.

Hybrid Approaches

Several studies combine multiple methods to improve failure detection accuracy. For example, combining statistical methods with machine learning techniques or using ensemble approaches can lead to more robust results.

Deep Learning and CNNs

CNNs, primarily designed for image recognition, have been adapted for time series data using image-like representations, like Gramian Angular Field (GAF) or Markov Transition Field (MTF). These approaches capture complex temporal patterns, making them effective for failure detection. However, CNNs may require larger datasets and longer training times.

Transfer Learning

Transfer learning has gained attention for failure detection in time series data. Pretrained models on similar domains or related tasks can be fine-tuned on specific failure detection datasets, reducing the need for extensive data collection and training. In conclusion, failure detection using time series data involves a broad range of techniques, each with its strengths and limitations. The choice of method depends on the specific characteristics of the data, the nature of the failures to be detected, the availability of labeled data, and the computational resources at hand. As the field of data-driven predictive maintenance continues to evolve, the combination of traditional statistical methods, machine learning algorithms, and deep learning techniques is likely to yield more accurate and efficient failure detection solutions.

Proposed Methodology of CNN

Figure 1 explain the steps for the proposed methods and Figure 2 shows the proposed encoder/decoder network architecture for Top-K DCCA (Divisive Correlation Clustering Algorithm). The encoder consists of three convolutional layers and the decoder consists of three unfolding layers. There is also a clustering module for encoder bottleneck indication. An autoencoder applies a stack of one-dimensional convolutional layers to both the encoder and decoder non convolutional layers. Encoder transforms multivariate

Transform time-series datasets into latent representations and extract relevant characteristics of datasets. The decoder then reconstructs the original dataset from the generic low-dimensional latent representation. Since the decoder reads the input based on the encoded representation of the bottleneck layer, i.e. for H. Conv 3 layers, the activation map from the Conv 3 layer can be viewed as the encoded representation of their stack input record. Therefore, it is clear that the coded representation has a testable relationship with the input features, as the decoder recreates the input features from the activation map of the coded representation. The input size for each level follows the naming convention (stack, number of sizes, number of levels, inputs, order of channels, length). Figure 2. Proposed architecture of a clustering-enhanced deep autoencoder for anomaly detection. In addition to the latent representation, we use a clustering engine to make the latent representation more nuanced so that we can better understand the difference between normal and abnormal behavior. As indicated, we use clustering only on a subset of latent representations selected based on various criteria described below.

The rationale behind this architectural choice is to find a middle ground between consistent latent representations to achieve good reconstruction accuracy while still allowing a subset of latent representations to be subjected to more sophisticated, downstream processing. to make it suitable. The architecture modules are detailed below. Combining autoencoder structures with CNNs is a standard approach for unsupervised deep learning in various image and video processing tasks [Ribeiro M, 2018]. Here, the encoder and decoder use convolutional and deconvolutional

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layers to extract important information in the latent representation. The similar approach for time series analysis as proposed in [Chadha G.S *et al,* 2021]. In this approach, sensor channels and the time dimension form the inputs to the network. As noted in the study, applying standard two-dimensional kernels is not suitable due to the lack of meaningful relationships between sensor channels, resulting in poor performance. A 1D convolution operation is performed on a portion of the total input space called the received field. Given each variable, we denote a receptive field of size nr m to step over the input T m sequence. The pth convolution 1D kernel of the first layer can be represented by the 2D tensor K(p) = [k(p) i,j] 2 Rnrm . Indices i, j specify dimensions along the time or variable axis. The extracted output or feature map from the convolution operation with the convolution kernel is a one-dimensional tensor H=[hi].

Typically, multiple convolution kernels are used in each convolution layer, resulting in multiple feature maps, which are then built into a 2D tensor H = [hi,p]. Each convolution kernel is responsible for extracting different features from the input data. Formally, the convolutional 1D operation can be summarized as follows:
(Batch - Size x Number of Input Channels x Sequence - Length)
In addition to the latent representation, can use a clustering engine to make the latent representation more nuanced so that to better understand the difference between normal and abnormal behavior. As indicated, can use clustering only on a subset of latent representations selected based on various criteria described below. The rationale behind this architectural choice is to find a middle ground between consistent latent representations to achieve good reconstruction accuracy while still allowing a subset of latent representations to be subjected to more sophisticated, downstream processing. to make it suitable.

Let's take a closer look at the architecture module. Combining autoencoder structures with CNNs is a standard approach for unsupervised deep learning in various image and video processing tasks [Ribeiro M, 2018]. Here, the encoder and decoder use convolutional and deconvolutional layers to extract important information in the latent representation. We use a similar approach for time series analysis as proposed in [Chadha G.S *et al*, 2021]. In this approach, sensor channels and the time dimension form the inputs to the network. As noted in the study, applying standard two-dimensional kernels is not suitable due to the lack of meaningful relationships between sensor channels, resulting in poor performance. A 1D convolution operation is performed on a portion of the total input space called the received field. Given each variable, we denote a receptive field of size nr m to step over the input T m sequence. The pth convolution 1D kernel of the first layer can be represented by the 2D tensor K(p) = [k(p)i,j] 2 Rnrm . Indices i, j specify dimensions along the time or variable axis. The extracted output or feature map from the convolution operation with the convolution kernel is a one-dimensional tensor H=[hi]. Typically, multiple convolution kernels are used in each convolution layer, resulting in multiple feature maps, which are then built into a 2D tensor H = [hi,p].Each convolution kernel is responsible for extracting different features from the input data. Formally, the convolutional 1D operation can be summarized as follows

$$h_{i,p} = (x * k)_i = \sum_{g=1}^{n_r} \sum_{f=1}^{m} x_{i+g-1,f} \cdot k_{g,f}^p$$

$$\forall i \in \{1, \ldots, T - n_r + 1\}$$

$$\forall p \in \{1, \ldots, d_{q+1}\},$$

→ Equation 1

In equation 1, where hi,p denotes the output of the (i)th received field and the pth convolution kernel, xi+gπ1, f are the elements of the received field of the input variable kg, f is the convolution kernel, dq+ 1 is , indicates the number of convolution kernels in the given shift. Convolution, also known as transposed convolution, performs the inverse operation of convolution such that each feature map is up sampled to the original input. The weights of the convolution and deconvolution filters can be bound, but are left unbound in this work.

Since the approach dealing with variable-length time series where the time dimension is important, can use a sliding window approach for the time dimension. So can define a window of size mw n with T >> mw > m and analyzed within his one processing step of the deep autoencoder. The time series of the time dimension is then extended by the SW step to define a new window to be processed in the next step. This approach has several advantages over processing the entire input sequence directly. In particular, a single data point fxig is processed multiple times with different settings, which increases the robustness of the resulting convolution kernel. This result was achieved by applying the proposed Top-K DCCA approach to a pure unsupervised learning environment. This means that error information labels were not used to train the model. The results achieved with the proposed approach are compared with the basic architecture and the standard DCCA approach, referred to below as the vanilla architecture

The standard architecture is a 3-layer convolutional architecture, but the top-K DCCA models have been tested on 2- and 3-layer convolutional layer architectures. The architectural description of the Top-K DCCA architecture is as follows[Maas, A.L, 2013]:

- Three convolutional layers with activation function LeakyReLU.
- All convolutional layers have a kernel size of 3
- The number of convolutional channels starts at 64 channels and doubles for each layer.
- The number of clustering channels is fixed at 128 at the bottleneck layer.
- A lot size of 20, a = 0.6, b = 0.001 is used.
- All models are trained for 100 epochs using an SGD (Stochastic Gradient Descent) optimizer with an L2 penalty of 0.02.

Figure 3, shows about the over all steps to be followed for the failure detection.

CONCLUSION

In conclusion, this study presents a novel and effective approach for air compressor failure detection using time series data and Convolutional Neural Networks (CNNs) in deep learning. By converting the time series data into grayscale images through the Gramian Angular Field (GAF) transformation, we harnessed the power of CNNs' image processing capabilities to capture intricate temporal patterns associated with different failure scenarios. The results demonstrate the viability and potential of CNNs for accurate and reliable air compressor failure detection. The customized CNN architecture, coupled with data augmentation techniques, achieved high accuracy in distinguishing between normal operating conditions and various failure modes. The model's robustness was validated through rigorous testing on an unseen dataset, indicating its ability to generalize well to real-world scenarios. The implications of this research are significant for industries relying on air compressor systems. The CNN-based failure detection system offers a proactive approach to predictive maintenance, enabling early detection of potential faults and preventing costly downtime and potential safety hazards. The utilization of time series data as images for CNN processing represents a novel and effective means to capture temporal dependencies, surpassing the limitations of traditional statistical methods in handling complex and dynamic failure patterns. Nevertheless, there are areas for future exploration and improvement. Fine-tuning the CNN architecture and hyperparameters may lead to even higher detection accuracy and efficiency. Additionally, investigating the incorporation of transfer learning techniques, where CNN models pretrained on related domains can be adapted, could mitigate the need for extensive data collection in specific scenarios.

As the field of deep learning and predictive maintenance continues to evolve, further research and development in this domain will enhance the capabilities of air compressor failure detection systems. It is essential to remain vigilant in monitoring the model's performance in real-world applications and to continuously update the model with new
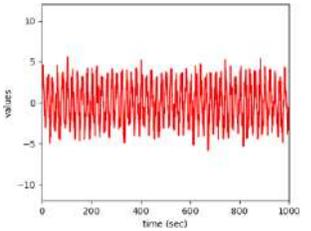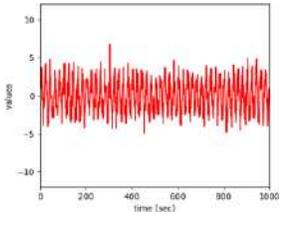
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data to adapt to changing operating conditions and potential novel failure scenarios. In conclusion, the integration of time series data with CNNs in deep learning has demonstrated significant potential for advancing failure detection methods in air compressor systems, ultimately contributing to improved operational efficiency, reduced maintenance costs, and enhanced safety across various industries

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Table 1. Different types of anomaly patterns

Anomaly Patterns	Descriptions	Examples	
Normal (assumption)	The amplitude and frequency are stable over time steps, and the time response is symmetrical		

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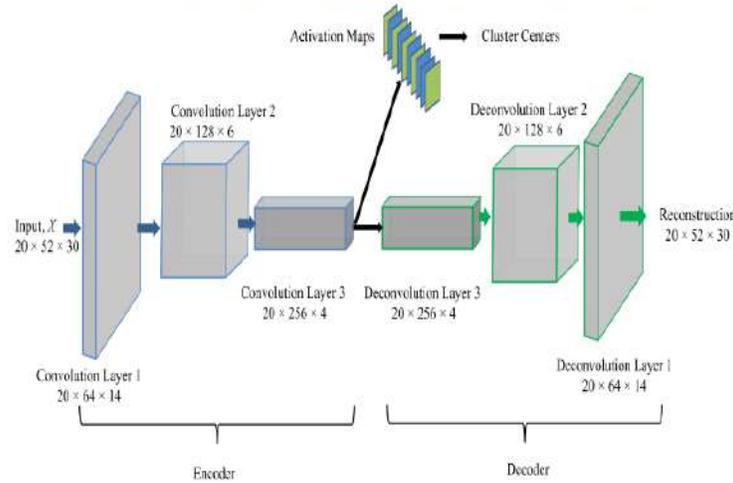|			
Missing	Most/all of the data are missing, and the time/frequency response becomes o		
Minor	Compared to normal sensor data, the vibration amplitude is very small		
Outlier	One or more outlier appear in the time response		
Square	The time response oscillates within a limiting range like a square wave		
Trend	The data has an obvious non-stationary and monotonous trend.		

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Figure 2 Clustering Augmented Deep Autoencoder for Anomaly Detection

Figure 3. Steps for Failure Detection

REVIEW ARTICLE

Implementation of Microaneurysms Detection using Morphological Linear Filtering with ML Classifiers

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ABSTRACT

Diabetes is one of the hazardous diseases in present era. Diabetic retinopathy is an eye disease which is caused due to diabetes. This condition affects the retina (blood vessels at the back of the eye), resulting in blindness. Diabetic retinopathy can occur in numerous ways, from no symptoms to minor vision impairments. In order to check whether a person got affected or not, the patient should visit a hospital, for the reports and should wait for long time. With the development of Machine learning techniques, there is an ability to look into the problem as well as rapid result. The aim of the examination is to develop a system which might classify the Microaneurysms (early diabetic retinopathy disease) of a patient with a better accuracy. This will remove the noise from fundus images uploaded by user by using hessian based morphological filtering techniques and machine learning classifiers to give accurate result. The performance evaluation of the developed system was tested by comparing with the ground truth of the publically available dataset IDRID.

Keywords: Diabetic Retinopathy (DR), Microaneurysms (MA) Fundus Images, Morphology, Machine learning, Accuracy

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INTRODUCTION

Medical imaging has a wide range of applications, including early detection of illnesses and treatment process monitoring [1]. The major goals of medical imaging enhancement are to reduce noise, improve contrast, and assist professionals in making an accurate diagnosis of disorders. Diabetes affects the retina of the eye which causes diabetic retinopathy disease. The retina, which is light-sensitive lining behind the eye, will be damaged. Diabetic Retinopathy mostly affects both the eyes. If the disease is not treated in the early stage, damaged blood vessels can cause vision loss. The DR disease is categorized as Proliferative and Non-Proliferative [2]. One of the first signs of DR that an ophthalmologist seesis MA, which is mostly caused by blood vessel leaks on the surface of the retina. The MAs resemble tiny circular spots on the retinal surface and have a round shape and a red tint. Hemorrhages develop on the retinal surface when the walls of MAs are breached. Exudates are created when blood that leaks from retinal blood vessels contains proteins and lipids. If these exudates build up close to the macula, they can cause complete blindness. The human eye's internal anatomy is made up of several different components, including the iris, macula, vessels, vitreous, optic disc, optic cup, cornea, pupil, etc. The veins in the eye are among the different eye elements that are crucial for analyzing and grading disorders like DR. Additionally existing techniques for diagnosing are remark- ably inefficient in light of the fact that it requires extremely enormous investment, because of which the treatment might lead to incorrect way.

 The fundus cameras are typically used to take images of the eye's interior architecture (retina). When Digital retinography is a popular noninvasive technique for screening and tracking the diseases of eye. Digital images from medical retinal scanning are frequently used in medical diagnosis to find the diseases of eye. Damage to capillaries in the eye is a complication of diabetic retinal diseases include diabetic retinopathy, diabetic macular edoema, glaucoma, and cataracts are shown in figure-1. determining the cause of various eye illnesses, the fundus images are crucial. A telescopic picture of the retinal structure is provided by the intricate optical system of fundus camera's, which is made up of several lenses [3]. The period of this infection has no indications of DR, so it transforms into a genuine challenge to identify it in the beginning stage. Based on the unparalleled breakthrough in Artificial Intelligence (AI) and supervised as well as unsupervised Machine Learning (ML), the accuracy of automated systems for segmenting reti- nal vessels is significantly increased. For the quick detection of eye illnesses, the large-scale implementation of an automated system based on machine learning is extremely important Numerous unsupervised experiments have been suggested to improve retinal images for vascular segmentation. To segment vessel formation, a variety of methods are used, including the morphological top-hat operator and derivatives of Gaus- sian [4], multi-scale morphology and seed point tracking [5], artificial bee colony optimization and fuzzy c-means [6], parallel pipeline median filtering [7] and Hybrid Fusion Method Combining Spatial Image Filtering [8]. The subject of retinal vascular segmentation is addressed in the literature using a variety of U-Net-based models, such as patch-based multi-scale dilated convolution [9], dual encoder scheme [10], second-order attention mechanism based on patche [8], [11], location attention module [12], a technique for cascading residual channel attention [13], and a back-propagation neural network model employed in [14].

This paper focuses mainly on the detection and categoriza- tion of DR based on the identification of MA in the fundoscopy images. The proposed algorithm minimizes problems such as over-fitting and under-fitting. The associated work in the field of clinical research as well as AI shows that, experts have proposed and implemented different AI systems, yet the general survey among these significant learning procedures is still missing at this point in light of everything. Prior investigations on DR disclosure used SVM and other AI estimations to orchestrate, and they are divided into several classes [15].

- **Image Pre-processing** In this phase the fundus image dataset shown in figure-2. The library is critical for image processing because it has a wealth of built-in functions for quick processing [15]. Noisy data is removed from the training images to improve their quality. All of the images have been resized to 128x128.
- **Image Augmentation** Sklearn(Scikit learn) is a library of Python for machine learning that is a simple and

efficient tool for predictive data analysis. It has multiple inbuilt functionalities that can perform certain tasks like image classification, regression, dimensionality reduction, model selection and preprocessing etc.

- **Image Classification phase** The dataset is divided into a training dataset and a testing dataset using the train- test-split function.
- **Machine learning models** LR, DT, SVM, RF, and KNN are used to determine whether an individual is affected by the DR disease or not, due to microaneurysms. Several functions are used to train the model to get good accuracy.
- **Testing** The model is tested using sample testing images to check model performance and obtain better results and accuracy.

These are all the phases involved in developing the model to predict the disease. Flow chart of the process is showed in figure-**3**.

METHODOLOGY

This segment involves the portrayal of the methodology used. The phases engaged in developing this methodology are as follows

Data Acquisition

Any sort of issue can be tackled using AI only when collection of data is provided for training and testing process. The DR dataset which is used is taken from IDRID comprising of high-resolution retina images. Subsequent to gathering the information from IDRID, the dataset is given to the pre-processing phase

PROPOSED WORK

As stated, the number of experts available is very small as compared to the number of diseased population. Thus the al- gorithms developed with the help of computers gives a reliable way to reduce the workload of experts. Microaneurysms (MA) is the key mark and the earliest occurring changes in the retina of a DR affected person. They are small, dark red, circular dots resulting due to swellings in retinal capillaries. The diameter of a Microaneurysms may range from 10 to 125 microns. Since MA are first occurring lesions for DR, their detection can help in early DR detection. The paper describes a simple method for MA detection using morphological techniques. Retinal MAs are focal dilatations of retinal capillaries. They are discrete, localized saccular distensions of the weakened capillary walls and appear as small round dark red dots on the retinal surface. According to the medical definition of MA [2], [16], it is a reddish, circular pattern with a diameter $\lambda < 125 \ \mu m$. We aim to find an MA by its diameter and isolated connected red pixels with a const ant intensity value, and whose external boundary pixels all have a higher value; in the green plane of a RGB image. A preprocessed retinal image is used as preliminary image for MA detection. Sensitivity, specificity, precision and accuracy are chosen as measurement of the accuracy of the algorithm s. All measures can be calculated based on four values, namely the true positive (TP) rate, the false positive (FP) rate, th e false negative (FN) rate, an d the true negative (TN) rate. These values are defined in Table-I . Sensitivity is the percentage of the actual MA pixels that are detected, and specificity is the percentage of non-MA pixels that are correctly classified as non-MA pixels. Precision is the percentage of detected pixels that are actually MAs. Accuracy is the overall per-pixel success rate o f the classifier. The sensitivity, sensitivity, precision and accuracy are computed using equation 1-4, respectively.

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$$Sensitivity = \frac{TP}{TP + FN} \qquad (1)$$

$$Specificity = \frac{TN}{TN + FN} \qquad (2)$$

$$Precision = \frac{TP}{TP + FP} \qquad (3)$$

$$Precision = \frac{TP + TN}{TP + TN + FP + FN} \qquad (4)$$

The numbers of MAs are also counted for automated grading of the severity of the DR. Example resulting images of MA detection are shown in Figure-4(a) to 4(h) The method presents the microaneurysms detection from color fundus images of the retina. The method is very simple which makes use of mathematical morphology functions for detection of microaneurysms. Pre-processing of Input Fundus Image Input image is the fundus image of the retina. Let it be denoted by I. Input image is an 8 bit RGB image. The process begins with the extraction. The next step is to remove the noise from the image. The MAs appear as small dark dots In the image. The smallest MA looks similar to a pepper noise. Hence the image is morphological filtered with the kernel size of 5 5 to remove the pepper noise from image. In the proo_sed method, first creates a kernel, which is a structuring element of size (5,5) and shape of an ellipse function. Then it applies two morphological filters, an opening and a closing filter, to the image function. Opening is the process of eroding the image followed by dilation, which is useful in removing noise. Closing is the reverse, dilation followed by erosion, which is useful in closing small holes or dark regions in the image. The kernel is used as the structuring element for both these operations. After that, it applies Sobel operator to find the derivative of the image in the x and y direction. Sobel operator uses a kernel to convolve the image and calculate the gradient of the image intensity. The dx variable stores the derivative of the image in the x direction and dy variable stores the derivative of the image in the y direction. For calculation of the Hessian matrix, which is the sum of the squares of dx and dy, by squaring dx and dy and adding them. In order to calculate the Hessian matrix, which is the sum of the squares of the partial derivatives of an image in the x and y direction, using the following steps:

1. Calculate the partial derivatives of the image in the x and y direction using the Sobel operator or any other derivative operator.
2. Square the values of the partial derivatives in the x and y direction.
3. Add the squared partial derivatives in the x and y direc- tion to get the Hessian matrix.
4. The partial derivatives of the image in the x and y direc- tion are stored in the dx and dy variables, respectively. These values are then squared using the ** operator and added together to calculate the Hessian matrix, which is stored in the hessian variable.
5. The hessian variable will hold the result.

It's worth noting that the Hessian matrix is a 2x2 matrix that contains the second order partial derivatives of the image intensity function. The matrix is used to detect interest points in an image, which can be used for feature detection and matching in computer vision tasks such as object recognition and image registration. The Hessian matrix is a 2x2 matrix that contains the second-order partial derivatives of the image intensity function. This can be done using the Sobel operator or any other derivative operator. The Sobel operator uses a kernel to convolve the image and calculate the gradient of the image intensity. It is used to detect interest points in an image, which can be used for feature detection and matching in computer vision tasks such as object recognition and image registration.

RESULTS AND DISCUSSION

The algorithm is tested on Indian Diabetic Retinopathy Im- age Dataset (IDRID). It is one of the first database representa- tive of an Indian population [17], consists of both normal, and DR images. This section explains the experimental findings for the suggested method. IDRID datasets were used for the tests in order to assess the effectiveness of the proposed DR system. 35,126 fundus photos taken by fundus cameras under various environmental circumstances are included in IDRID datasets. The five fundus image types used in the standard IDRID dataset are non-DR, mild severe, moderate severe, severe, and PDR with varying percentages, as indicated in Table. First, fundus images were scaled down to 224×224 pixels in order to achieve efficient computational results. The pre-processing operation was next carried out for better outcomes, then microaneurysm segmentation. To obtain a flexible implemen- tation of the logistic regression, SVM, and KNN were used to obtain the significant results. Sensitivity, specificity, precision and accuracy in this experiment are 81.61%, 99.99%, 63.76% and 99.98%, respectively. The accuracy curves of proposed method with different classifiers are shown the figure-5.

CONCLUSION

The number of diabetic patients has risen during the past several years. As a result, diabetic retinopathy (DR) is now a significant problem. Deep neural networks have been utilised to tackle this issue by playing a crucial part in identifying the symptoms in the very early stages of DR. The feature extraction of retinal fundus pictures for the proposed DR classification system was done using the logistic regression, Random forest, Decision Tree, SVM, and KNN methods. Sen-sitivity, specificity, precision and accuracy in this experiment are 81.61%, 99.99%, 63.76% and 99.98%, respectively.

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Table I: Pixel Based Evaluation

	Disease Status	
Test Result	**Present**	**Absent**
Positive	True Positive(TP)	False Positive(FP)
Negative	False Negative(FN)	True Negative(TN)

Table II: Performance comparison of different type of dia- betic retinopathy

[5.0 ex] Methods	Sensitivity	Specificity	Acc
Soomro et al. 2019 [18]	82.90	96.10	96.20
Wang et al. 2019 [19]	N/A	N/A	95.73
Islam et al. 2020 [20]	81.00	92.00	N/A
Zhao et al. 2020 [21]	78.09	98.18	N/A
Cherukuri et al. 2020 [22]	81.44	97.33	95.88

Jena et al. 2021 [23]	N/A	N/A	94.96
Guo et al. 2021 [23]	79.26	97.64	95.91
Yatuk et al. 2022 [8]	83.35	98.32	96.37
Logistic Regression*	77.25	94.33	92.9
Decision Tree*	82.71	95.13	90.5
KNN*	82.97	94.16	**96.3**
SVM*	86.35	99.16	**97.5**
Random forest*	81.61	99.99	**98.5**
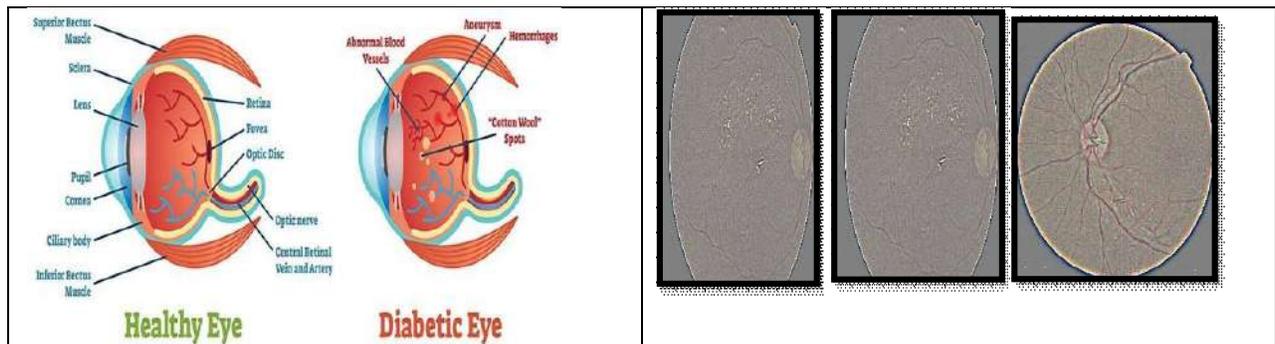
Figure-1: Difference between Healthy eye and Diabetic eye.

Figure-2: Difference type of datasets.
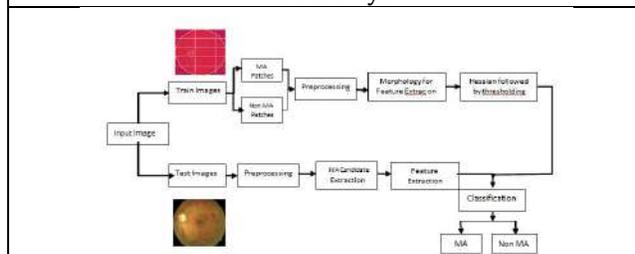
Figure-3: Flow chart of the proposed architecture.
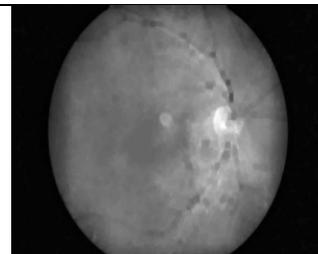
Figure-4 Microaneurysm detection (a) Image after closing

Figure-4(b) F illed-in image
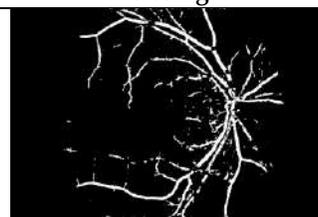
Figure-4(c) Difference image

Figure-4 (d) Image after removal of object smaller than the size of microaneurysm from image.
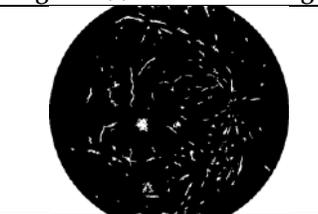
Figure-4(e) Extended-minima transform image.

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Figure-4(f) Image after removalof vessels	**Figure-4(g) Detected microaneurysms**
Figure-4(h) Microaneurysms superimposed on original image.	**Figure-5**

REVIEW ARTICLE

Properties of k– Perhermitian and k– Skew Perhermitian Matrices

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ABSTRACT

In this paper we introduced the basic concept of k - Hermitian Matrix, some Properties of Hermitian Matrix given. Our Intention is to define $k-$ Perhermitian and $k-$ SkewPerhermitian as a Generalized of $k-$ Perhermitian extend many of the basic concept and theorems on $k-$ Perhermitian Matrix. Also we discussed $k-$ SkewPerhermitian basic concept, therorems and example are given.

Keywords: *Hermitian , $k-$ Hermitian, $k-$ Perhermitian, $k-$ Skew Perhemitian..*

INTRODUCTION

Centrosymmetry corresponds to symmetry about the centre of the Matrix Persymmetry is symmetry across the secondary main diagonal. Ann Lec [1] has discussed secondary symmetric and skew symmetric secondary orthogonal matrices Cantoni and Butler[2] have studied Eigenvalue and Eigenvactors of symmetric centrosymmetric matrices, James and Weaver][3] have characterize centrosymmetric(cross symmetrices) their basic properties, Eigenvalue and Eigenvectors, Hazewinkel and Michiel[4] have studied symmetric matrices, Hill Bules and Waters[5] have focused on Perhermitian , Haze winkel and Michiel [6] have studied Hermitian matrix, Hill and Wters have studied On k– Real and k– Hermitian matrices. Here Skew Perhemitian is equal to S Perhemitian.

Definition 1

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A square matrix P be complex number of order n × n is said to be hermitian if $P = P^H$

(ie) $p_{ij} = \overline{p_{ij}} \, \forall \overline{i, j}$.

Definition 2

A square matrix P be complex number of order n × n is said to be Perhermitian if   the elements of P satisfy the relation $p_{ij} = \overline{p_{n+1-j,n+1-i}}$ (ie) $P = P^H$

Preliminaries and Notations

Let P is Perhermitian , P^H is conjugate transpose of P . Let K be a fixed product of disjoint transposition in S_n and a Perhermitian K associated with KI , K satisfies the properties $K^2 = I$, $K^T = K$

Theorem 1

Let P be complex number of order n × n is k−Perhermitian then $P = KP^H K$

Proof.

$$KP^H K = KPK \text{ where } P^H = P$$

$$= PKK \text{ where } PK = P^H K$$

$$= PK^2 = P.$$

Theorem 2

Let P be complex number of order n × n is k−Perhermitian then $P^H = KPK$

Proof.

$$KPK = KP^H K \text{ where } P = P^H$$

$$= P^H KK \text{ where } KP^H = P^H K$$

$$= P^H K^2 = P^H.$$

Example

Let $P = \begin{pmatrix} 9 & 2+3i & 10 \\ 2-3i & 7 & 2-3i \\ 10 & 2+3i & 9 \end{pmatrix}$, $P^H = \begin{pmatrix} 9 & 2+3i & 10 \\ 2-3i & 7 & 2-3i \\ 10 & 2+3i & 9 \end{pmatrix}$

(i) $KP^H K = \begin{pmatrix} 0 & 0 & 1 \\ 0 & 1 & 0 \\ 1 & 0 & 0 \end{pmatrix} \begin{pmatrix} 9 & 2+3i & 10 \\ 2-3i & 7 & 2-3i \\ 10 & 2+3i & 9 \end{pmatrix} \begin{pmatrix} 0 & 0 & 1 \\ 0 & 1 & 0 \\ 1 & 0 & 0 \end{pmatrix}$

$= \begin{pmatrix} 10 & 2+3i & 9 \\ 2-3i & 7 & 2-3i \\ 9 & 2+3i & 10 \end{pmatrix} \begin{pmatrix} 0 & 0 & 1 \\ 0 & 1 & 0 \\ 1 & 0 & 0 \end{pmatrix}$

$$= \begin{pmatrix} 9 & 2+3i & 10 \\ 2-3i & 7 & 2-3i \\ 10 & 2+3i & 9 \end{pmatrix}$$

$$= P$$

(i) $KPK = \begin{pmatrix} 0 & 0 & 1 \\ 0 & 1 & 0 \\ 1 & 0 & 0 \end{pmatrix} \begin{pmatrix} 9 & 2+3i & 10 \\ 2-3i & 7 & 2-3i \\ 10 & 2+3i & 9 \end{pmatrix} \begin{pmatrix} 0 & 0 & 1 \\ 0 & 1 & 0 \\ 1 & 0 & 0 \end{pmatrix}$

$$= \begin{pmatrix} 10 & 2+3i & 9 \\ 2-3i & 7 & 2-3i \\ 9 & 2+3i & 10 \end{pmatrix} \begin{pmatrix} 0 & 0 & 1 \\ 0 & 1 & 0 \\ 1 & 0 & 0 \end{pmatrix}$$

$$= \begin{pmatrix} 9 & 2+3i & 10 \\ 2-3i & 7 & 2-3i \\ 10 & 2+3i & 9 \end{pmatrix}$$

$$= P^H$$

Theorem 3

If P be complex number of order $n \times n$ is $k-$Perhermitian then $P + P^H$ is also $k-$Perhermitian

Proof.

A Matrix P be complex number of order $n \times n$ is $k-$Perhermitian then $P = KP^H K$ .Since P^H is also $k-$ Perhermitian then $P^H = KPK$

To prove $P + P^H$ is also $k-$ Perhermitian

show that $P + P^H = K(P + P^H)K$

Now $K(P + P^H)K$ $\quad = K(P + P^H)^H K$

$= K(P^H + (P^H)^H)K$

$= K(P^H + P)K$

$= KP^H K + KPK$

$= P + P^H.$

Example

Let $P = \begin{pmatrix} 4 & 2+5i & 5 \\ 2-5i & 6 & 2-5i \\ 5 & 2+5i & 4 \end{pmatrix}, \qquad P^H = \begin{pmatrix} 4 & 2+5i & 5 \\ 2-5i & 6 & 2-5i \\ 5 & 2+5i & 4 \end{pmatrix}$

$P + P^H = \begin{pmatrix} 8 & 4+10i & 10 \\ 4-10i & 12 & 4-10i \\ 10 & 4+10i & 8 \end{pmatrix}, \quad (P + P^H)^H = \begin{pmatrix} 8 & 4+10i & 10 \\ 4-10i & 12 & 4-10i \\ 10 & 4+10i & 8 \end{pmatrix}$

$$K(P + P^H)^H = \begin{pmatrix} 0 & 0 & 1 \\ 0 & 1 & 0 \\ 1 & 0 & 0 \end{pmatrix} \begin{pmatrix} 4 & 2+5i & 5 \\ 2-5i & 6 & 2-5i \\ 5 & 2+5i & 4 \end{pmatrix} \begin{pmatrix} 0 & 0 & 1 \\ 0 & 1 & 0 \\ 1 & 0 & 0 \end{pmatrix}$$

$$= \begin{pmatrix} 8 & 4+10i & 10 \\ 4-10i & 12 & 4-10i \\ 10 & 4+10i & 8 \end{pmatrix}$$

$$= P + P^H.$$

Theorem 4

If P be complex number of order n×n is k−Perhermitian PP^H and P^HP is also k−Perhermitian .

Proof.

A Matrix P be complex number of order n×n is k−Perhermitian then P = KP^HK .since P^H is also k−Perhermitian then $P^H = KPK$.

show that

$$K(PP^H)^HK = K((P^H)^HP^H)K$$

$$= K(PP^H)K$$

$$= (PP^H)^H$$

$$= (P^H)^HP^H$$

$$= PP^H.$$

Similarly $K(P^HP)^HK = P^HP$

Example

$$\text{Let } P = \begin{pmatrix} 8 & 4+2i & 10 \\ 4-2i & 6 & 4-2i \\ 10 & 4+2i & 8 \end{pmatrix}, \qquad P^H = \begin{pmatrix} 8 & 4+2i & 10 \\ 4-2i & 6 & 4-2i \\ 10 & 4+2i & 8 \end{pmatrix}$$

$$PP^H = \begin{pmatrix} 184 & 96+48i & 180 \\ 96-48i & 76 & 96-48i \\ 180 & 96+48i & 184 \end{pmatrix}, \quad (PP^H)^H = \begin{pmatrix} 184 & 96+48i & 180 \\ 96-48i & 76 & 96-48i \\ 180 & 96+48i & 184 \end{pmatrix}$$

$$K(P + P^H)^H = \begin{pmatrix} 0 & 0 & 1 \\ 0 & 1 & 0 \\ 1 & 0 & 0 \end{pmatrix} \begin{pmatrix} 184 & 96+48i & 180 \\ 96-48i & 76 & 96-48i \\ 180 & 96+48i & 184 \end{pmatrix} \begin{pmatrix} 0 & 0 & 1 \\ 0 & 1 & 0 \\ 1 & 0 & 0 \end{pmatrix}$$

$$= \begin{pmatrix} 184 & 96+48i & 180 \\ 96-48i & 76 & 96-48i \\ 180 & 96+48i & 184 \end{pmatrix}$$

$$=PP^H.$$

Theorem 5

If P and Q are k−Perhermitian then PQ is also k−Perhermitian .

Proof.

Let P and Q are k− Perhermitian then P = KP^{H}K , Q = KQ^{H}K . Since P^H and Q^H are also k−Perhermitian , then P^H = KPK, Q^H = KQKTo prove PQ is k− Perhermitian
show that PQ = K(PQ)^{H}K

Now

$$\begin{aligned} K(PQ)^H K &= K(Q^H P^H)K \\ &= K(KQK)(KPK)K \\ &= K^2 Q K^2 P \\ &= QP = PQ. \end{aligned}$$

Example

Let $P = \begin{pmatrix} 6 & 2i \\ -2i & 6 \end{pmatrix}, Q = \begin{pmatrix} 7 & 3i \\ -3i & 7 \end{pmatrix}$

$PQ = \begin{pmatrix} 48 & 32i \\ -32i & 48 \end{pmatrix}, \quad (PQ)^H = \begin{pmatrix} 48 & 32i \\ -32i & 48 \end{pmatrix}$

$$\begin{aligned} K(PQ)^H &= \begin{pmatrix} 0 & 1 \\ 1 & 0 \end{pmatrix} \begin{pmatrix} 48 & 32i \\ -32i & 48 \end{pmatrix} \begin{pmatrix} 0 & 1 \\ 1 & 0 \end{pmatrix} \\ &= \begin{pmatrix} 48 & 32i \\ -32i & 48 \end{pmatrix} \\ &= PQ. \end{aligned}$$

Theorem 6

If P and Q are k− Perhermitian of same order then $\lambda_1 P + \lambda_2 Q$ is also k−Perhermitian .Where λ_1 and λ_2 are scalar.

Proof.

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Let P and Q are k−Perhermitian then $P = KP^HK$ and $Q = KQ^HK$.

Since P^H and Q^H are also k− Perhermitian, then $P^H = KPK$, $Q^H = KQK$. Now let us show that, $\lambda_1 P + \lambda_2 Q$ is k−Perhermitian.

For

$$\text{consider} \quad K(\lambda_1 P + \lambda_2 Q)^H K \quad = \quad K(\lambda_1 P^H + \lambda_2 Q^H)K$$

$$= \quad \lambda_1 K P^H K + \lambda_2 K Q^H K$$

$$= \quad \lambda_1 P + \lambda_2 Q$$

Theorem 7

If P and Q are k−Perhermitian of same order then PQ + QP is also k−Perhermitian.

Proof.

Let P and Q are k−Perhermitian then $P = KP^HK$ and $Q = KQ^HK$. Since P^H and Q^H are also k−Perhermitian, then $P^H = KPK$, $Q^H = KQ$

To Prove PQ + QP is k−Perhermitian, show that

$$K(PQ + QP)^H K = K((PQ)^H + (QP)^H)K$$

$$= \quad K(PQ)^H K + K(QP)^H K$$

$$= \quad KPQK + KQPK$$

$$= \quad PQ + QP.$$

Example

$$\text{Let } P = \begin{pmatrix} 6 & 2i \\ -2i & 6 \end{pmatrix}, Q = \begin{pmatrix} 7 & 3i \\ -3i & 7 \end{pmatrix}, \quad PQ = \begin{pmatrix} 48 & 32i \\ -32i & 48 \end{pmatrix}$$

$$QP = \begin{pmatrix} 48 & 32i \\ -32i & 48 \end{pmatrix}, \quad PQ + QP = \begin{pmatrix} 48 & 32i \\ -32i & 48 \end{pmatrix}, \quad (PQ + QP)^H = \begin{pmatrix} 96 & 64i \\ -64i & 96 \end{pmatrix}$$

$$K(PQ + QP)^H = \begin{pmatrix} 0 & 1 \\ 1 & 0 \end{pmatrix} \begin{pmatrix} 96 & 64i \\ -64i & 96 \end{pmatrix} \begin{pmatrix} 0 & 1 \\ 1 & 0 \end{pmatrix}$$

$$= \begin{pmatrix} 96 & 64i \\ -64i & 96 \end{pmatrix}$$

$$= PQ + QP.$$

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Theorem 8

Let P be complex number of order $n \times n$ is k– Perhermitian then KP is also k–Perhermitian .

Proof.

A matrix P be complex number of order $n \times n$ is k– Perhermitian then $KP^HK = P$ .Since P^H is also is k– Perhermitian then $KPK = P^H$

We will show that,

$$\text{Now } K(KP)^HK = K(K^HP^HK)$$
$$= KP^H(KK^H)$$
$$= K(P)$$
$$= K$$

Definition 3

A square matrix P be complex number of order $n \times n$ is said to be Skew hermitian if

$-P = P^H$

(ie) $p_{ij} = -p_{ij}$ $\forall \overline{i, j}$.

Definition 4

A square matrix P be complex number of order $n \times n$ is said to be S Perhermitian if   the elements of P satisfy the relation $p_{ij} = \overline{-p_{n+1-j, n+1-i}}$ (ie) $-P = P^H$

Theorem 9

Let P be complex number of order $n \times n$ is k– S Perhermitian then $-P = KP^HK$

Proof.

$KP^HK = K(-P)K$ where $P^H = -P$

$= -PK = -P$.

Theorem 10

Let P be complex number of order $n \times n$ is k– S Perhermitian then $-P^H = KPK$

Proof.

$$KPK = K(-P^H)K$$
$$= -P^HK^2 = -P^H$$

Example

$$\text{Let } P = \begin{pmatrix} 7i & 4-6i & 0 \\ -4-6i & 0 & -4-6i \\ 0 & 4-6i & 7i \end{pmatrix}, \quad P^H = \begin{pmatrix} -7i & -4+6i & 0 \\ 4+6i & 0 & 4+6i \\ 0 & -4+6i & -7i \end{pmatrix}$$

$$KPK = \begin{pmatrix} 0 & 0 & 1 \\ 0 & 1 & 0 \\ 1 & 0 & 0 \end{pmatrix} \begin{pmatrix} 7i & 4-6i & 0 \\ -4-6i & 0 & -4-6i \\ 0 & 4-6i & 7i \end{pmatrix} \begin{pmatrix} 0 & 0 & 1 \\ 0 & 1 & 0 \\ 1 & 0 & 0 \end{pmatrix}$$

$$= \begin{pmatrix} 0 & 4-6i & 7i \\ -4-6i & 0 & -4-6i \\ 7i & 4-6i & 0 \end{pmatrix} \begin{pmatrix} 0 & 0 & 1 \\ 0 & 1 & 0 \\ 1 & 0 & 0 \end{pmatrix}$$

$$= \begin{pmatrix} 7i & 4-6i & 0 \\ -4-6i & 0 & -4-6i \\ 0 & 4-6i & 7i \end{pmatrix}$$

$$= -P^H.$$

Theorem 11

Let P be complex number of order n × n is k−S Perhermitian then KP is also k−SPerhermitian .

Proof.

A matrix P be complex number of order n × n is k−S Perhermitian then $KP^HK = -P$.

Since P^H is also is k− S Perhermitian then $KPK = -P^H$

We will show that, $KP = -K(KP)^HK$

$$\text{Now } K(KP)^HK = -K(P^HK^HK)$$
$$= -K(P^H(KK^H))$$
$$= -K(P^HI)$$
$$= -K(-P) = KP.$$

Example

$$\text{Let } P = \begin{pmatrix} 4i & 8+2i & 0 \\ -8+2i & 0 & -8+2i \\ 0 & 8+2i & 4i \end{pmatrix}, \quad P^H = \begin{pmatrix} -4i & -8-2i & 0 \\ 8-2i & 0 & 8-2i \\ 0 & -8-2i & -4i \end{pmatrix}$$

$$KP = \begin{pmatrix} 0 & 8+2i & 4i \\ -8+2i & 0 & -8+2i \\ 4i & 8+2i & 0 \end{pmatrix}, (KP)^H = \begin{pmatrix} 0 & -8-2i & -4i \\ 8-2i & 0 & 8-2i \\ -4i & -8-2i & 0 \end{pmatrix}$$

$$KP = -K(KP)^HK$$

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$$= \begin{pmatrix} 0 & 0 & 1 \\ 0 & 1 & 0 \\ 1 & 0 & 0 \end{pmatrix} \begin{pmatrix} \mathbf{0} & -\mathbf{8}-\mathbf{2i} & -\mathbf{4i} \\ \mathbf{8}-\mathbf{2i} & \mathbf{0} & \mathbf{8}-\mathbf{2i} \\ -\mathbf{4i} & -\mathbf{8}-\mathbf{2i} & \mathbf{0} \end{pmatrix} \begin{pmatrix} 0 & 0 & 1 \\ 0 & 1 & 0 \\ 1 & 0 & 0 \end{pmatrix}$$

$$= -\begin{pmatrix} \mathbf{0} & -\mathbf{8}-\mathbf{2i} & -\mathbf{4i} \\ \mathbf{8}-\mathbf{2i} & \mathbf{0} & \mathbf{8}-\mathbf{2i} \\ -\mathbf{4i} & -\mathbf{8}-\mathbf{2i} & \mathbf{0} \end{pmatrix}$$

$$= \begin{pmatrix} \mathbf{0} & \mathbf{8}+\mathbf{2i} & \mathbf{4i} \\ -\mathbf{8}+\mathbf{2i} & \mathbf{0} & -\mathbf{8}+\mathbf{2i} \\ \mathbf{4i} & \mathbf{8}+\mathbf{2i} & \mathbf{0} \end{pmatrix}$$

$= KP.$

Theorem 12

If P and Q are $k-$ S Perhermitian matrix then PQ is also $k-$ S Perhermitian matrix.

Proof.

Let P and Q are $k-$ S Perhermitian matrix then $-P = KP^HK$, $-Q = KQ^HK$. Since P^H and Q^H are also $k-$ S Perhermitian , then $-P^H = KPK$, $-Q^H = KQK$. Toprove PQ is $k-$ S Perhermitian we will show that $PQ = K(PQ)^HK$ Now

$$\begin{aligned} K(PQ)^HK &= K(Q^HP^H)K \\ &= K(-KQK)(-KPK)K \\ &= K^2QK^2PK^2 \\ &= QP = PQ. \end{aligned}$$

Theorem 13

If P and Q are $k-$ S Perhermitian of same order then $PQ - QP$ is also $k-$ SPerhermitian.

Proof.

Let P and Q are $k-$ S Perhermitian then $-P = KP^HK$ and $-Q = KQ^HK$. Since P^H and Q^H are also $k-$ S Perhermitian, then $-P^H = KPK$, $-Q^H = KQK$ .To Prove $PQ - QP$ is $k-$ S Perhermitian ,

We will show that $PQ - QP = K(PQ - QP)^HK$

$$\begin{aligned} K(PQ - QP)^HK &= K((PQ)^H - (QP)^H)K \\ &= K(PQ)^HK - K(QP)^HK \\ &= K(Q^HP^H)K - K(P^HQ^H)K \\ &= K[(-KQK)(-KPK)]K - K[(-KPK)(-KQK)]K \\ &= K^2PK^2QK^2 - K^2QK^2PK^2 \\ &= PQ - QP. \end{aligned}$$

Theorem 14

If P be complex number of order $n \times n$ is k– S Perhermitian then $P - P^H$ is also k–S Perhermitian

Proof.

A Matrix P be complex number of order $n \times n$ is k– S Perhermitian then $-P = KP^H K$. Since P^H is also k– S Perhermitian then $-P^H = KPK$

The prove $P - P^H$ is also k– S Perhermitian show that $P - P^H = K(P - P^H)K$ Now $K(P - P^H$

$)^H K$

$$= -[K(P - P^H)^H]K$$

$$= -[K(P^H - (P^H)^H)]K$$

$$= -[K(P^H - P)K]$$

$$= -[KP^H K - KPK]$$

$$= -[-P - (-P^H)]$$

$$= P - P^H.$$

Example

Let $P = \begin{pmatrix} 8i & 12+7i & 0 \\ -12+7i & 0 & -12+7i \\ 0 & 12+7i & 8i \end{pmatrix}$, $P^H = \begin{pmatrix} -8i & -12-7i & 0 \\ 12-7i & 0 & 12-7i \\ 0 & -12-7i & -8i \end{pmatrix}$

$P - P^H = \begin{pmatrix} 16i & 24+14i & 0 \\ -24+14i & 0 & -24+14i \\ 0 & 24+14i & 16i \end{pmatrix}$, $(P - P^H)^H = \begin{pmatrix} -16i & -24-14i & 0 \\ 24-14i & 0 & 24-14i \\ 0 & -24-14i & -16i \end{pmatrix}$

-     $-K(P - P^H)^H K = -\begin{pmatrix} 0 & 0 & 1 \\ 0 & 1 & 0 \\ 1 & 0 & 0 \end{pmatrix} \begin{pmatrix} -16i & -24-14i & 0 \\ 24-14i & 0 & 24-14i \\ 0 & -24-14i & -16i \end{pmatrix} \begin{pmatrix} 0 & 0 & 1 \\ 0 & 1 & 0 \\ 1 & 0 & 0 \end{pmatrix}$

$= -\begin{pmatrix} -16i & -24-14i & 0 \\ 24-14i & 0 & 24-14i \\ 0 & -24-14i & -16i \end{pmatrix}$

$= \begin{pmatrix} 16i & 24+14i & 0 \\ -24+14i & 0 & -24+14i \\ 0 & 24+14i & 16i \end{pmatrix}$

$= P - P^H.$

CONCLUSION

We introduceed the concept of k -Perhermitian and k - S Perhermitian , We also described a method for finding the basic concept and theorems on k -Perhermitian andk - S Perhermitian example are given

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REVIEW ARTICLE

Automatic Diabetic Retinopathy Detection using Convolutional Neural Networks

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ABSTRACT

India is known as the "Diabetes Capital of the World," indicating that it has the world's biggest number of diabetes cases. Diabetes is a common illness in India as well as the rest of the world. On the other hand, an increase in blood sugar levels can cause severe complications such as Diabetic Retinopathy and Diabetic Neuropathy. We will be dealing with Diabetic Retinopathy, often known as Diabetic Eye Disease, in this project. As previously stated, it is caused by excessive increase in blood sugar levels due to diabetes. Diabetic Retinopathy is a disorder that disturbs the fundus in the eye and can have serious concerns if left untreated. If not treated early on, it might result in permanent blindness. This permanent loss of vision , however, can be avoided if detected early. Hence, we are proposing method that can help us in detection of Diabetic Retinopathy in advance and take preventive measures against it.

Keywords: Diabetic retinopathy, convolutional neural networks, retina, blood sugar

INTRODUCTION

The healthcare industry is one of India's greatest industries, and it has grown more effective when ailments are diagnosed and treated early on. Diabetes is a disease in which blood sugar levels rise as a result of a lack of insulin in the body. According to the studies it is known that diabetes affects around 425 million adults across the world[2]. It not only increases blood sugar levels but also affects other parts of body like the nerves, heart,retina, and kidneys [1][2]. In this project we are dealing with Diabetic Retinopathy(DR), an eye disease. Diabetic Retinopathy is a diabetic disorder that causes the retina's blood vessels to deepen and results in outflow fluids and blood. If DR progresses to an advanced extent, it might result in vision damage. DR is responsible for 2.6 percent of all blindness worldwide.

Patients with diabetes who have been unwell for a long period are more prone to develop DR. Regular retina screening is necessary for diabetic individuals to identify and treat diabetic retinopathy (DR) at its early stage in order to avert blindness. The presence of various sorts of lesions on a retina picture is used to detect DR[3].

Diabetic Retinopathy is a type of disease that can be caused to any person who is suffering from diabetes. It can be detected by the appearance of microaneurysms (MA), hemorrhages (HM), hard and soft exudates (EX). In general, there are four stages of Diabetic Retinopathy. Below is a list of them.

1. Microaneurysms only present in mild non-proliferative DR.
2. Moderate non-proliferative DR: Microaneurysms and other vascular abnormalities (example: hard exudates, cotton wool spots dot and blot haemorrhages).
3. Severe non-proliferative DR: It also includes intraretinal haemorrhages (20 per quadrant), obvious venous pelleting in two quadrants, or microvascular anomalies in one quadrant.
4. Proliferative DR:Severe nonproliferative DR with at least one neovascularization/vitreous/pre-retinal haemorrhage.

The goal of this research is to classify an eye image (either right or left) into one of the following classes of eyesight: 0 indicates no DR, 1 shows mild DR, 2 shows moderate DR, 3 indicates severe DR, and 4 shows Proliferative DR. As a result, our mission is to develop an sovereign analytic system capable of recognising and naming illness types.The following figures[1.1,1.2,1.3,1.4 and 1.5] shows the various stages of DR.

LITERATURE SURVEY

Carrera suggested an unique technique to detect Diabetic Retinopathy from input retinal images using Digital Image Processing in 2016 [9]. It was put to the test on 400 retinal pictures from a database. Rao devised a hybrid technique in 2016 that combined morphological processing and fuzzy C-means clustering with SVM classifier to detect exudates and microaneurysms (lesions) in raw retinal images. In 2016, Yadav published a study that looked at various fundus/retinal image enhancing techniques that can be used to detect Diabetic Retinopathy [5]. In 2016, Gupta presented a method for detecting blood vessels in the eye[6]. It was accomplished using Gaussian filtering and the Morphological Administrator. Seoud introduced a method for automatically detecting and validating haemorrhages and micro aneurysms using a given colour fundus image in 2016[7]. Karami presented a dictionary learning (DL)-based technique in 2017. It was created utilising the K-SVD technique to construct the best atomic representation of fundus images based on pre-learned dictionaries.

The Proposed System's Architecture

In this project, we have rendezvous a user interface using HTML and CSS, using which the user can embed/upload an input image. After uploading the image, the image is then sent the trained model for classification, in this phase it undergoes several steps. In first step, the input image undergoes pre-processing in order to filter the noise if any present in that image. After that pre-processed image will be used for selecting the features. The features will be selected and the model gets trained that helps to predict whether the input image has Diabetic Retinopathy or not. After that outcomes reinstate back to the User interface and are displayed in a new web page.

Implementation

The project involved in the development of the mode (using CNN) that helps in detecting whether a person is affected by the disease or not. In order to perform the image pre-processing we have used python tools namely pillow for image transformations.

Convolutional Neural Networks, also known as Shift Invariant or Space Invariant Artificial Neural Networks, are a type of Deep Neural Network used in Deep Learning (SIANN). Between the input layer and the output layer, there are multiple hidden layers. Shared weight architecture is used for calculation of weights at each nodes in the network. It is fully connected and was inspired by biological process in human brain. Fig .4 depicts the steps involved in CNN.

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Algorithm CNN

Step 1:Convolution Operation – the image becomes abstracted to a feature map ReLU layer - A Rectified Linear Unit layer, produces a linear functionalit

Step 2: Pooling - Convolutional networks can be neighborhood or worldwide pooling layers to speed up the concealed calculation. Pooling layers lessen the dimensionality of data by linking the outputs of dendrite clusters at one layer into a single dendrite at the subsequent layer.

Step 3: Flattening – moves from pooled to flattened layers

Step 4: Full connection – In completely associated layers, every dendrite in one layer is associated with each and every dendrite in the following layer.The inputs are always taken in tensor format in CNN, where it contains input image height, weight and number of channels.

Convolution layers are a series of resemblant point maps generated by sliding multiple kernels (feature detectors) across an input and projecting element wise dot(or pixel) as feature maps, assuming the input of the convolution Neural network has the dimension H,W,C (stacked together). still, k2, C confines, If each kernel in the set k1, k2, C dimensions, then K_d := size of the set determines how many output layers the convolution layer will have. Assume there's a stride Zs that represents the sliding element of the point chart, as well as a zero-padding parameter Z_P that regulates the size of the point charts and kernels. The resultant dimension of such a convolution layer will then be H1 x W1 x D1

(H1, W1, D1) = ((H + 2Zp − k1)/ Zs + 1 , (W + 2Zp − k2)/ Zs + 1 , K_d)

Activation functions define a neuron's output based on a collection of inputs. For non-linear transformation the proportion of direct net input value is processed via an activation function. An example of typical activation. The capability is founded on restrictive likelihood. and it returns one or zero as a result.

ReLU : f(x) = { 0 for x< 0, x for x >= 0}

f '(x)= { 0 for x < 0 , 1 for x >= 0 }

Pooling layers is the process of downsampling a layer's total output to a single dendrite. If we indicate k as the size of the kernel (currently accepted as square)), D_n as the number of windows in the kernel., and Z_s as the pace to construct pooling layers, then the pooling layer's output dimension will be (assuming H1,W1,D1 input):

H2 × W2 × D2, where (H2, W2, D2) = ((H1 − k)/Z_s + 1, (W1 − k)/Z_s + 1, D_n)

RESULTS AND DISCUSSION

The accuracy of the model is around 88% and is able to predict the 4 types of Diabetic Retinopathy along with No DR. Fig 5.1 and 5.2 provide the details of the testing and training for the given model.

CONCLUSION

This paper aims to assist the user in detecting diabetic retinopathy easily and the trained model has shown an accuracy of 88%. Considering this model might improve the accuracy, with large volume of images. This application can also be used by ophthalmologists in diagnosing the disease. The classification of the input image is carried out in accordance with the presence of microaneurysms, both hard and soft exudates, small dots, leaky blood vessels in the retinal image. The application was tested with various input images, and the images are classified into one of the 5 stages hence showcased the best results as depicted in section 5.

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Fig.1.1. No DR	**Fig.1.2. Mild DR**
Fig.1.3 Moderate DR	**Fig.1.4. Severe DR**
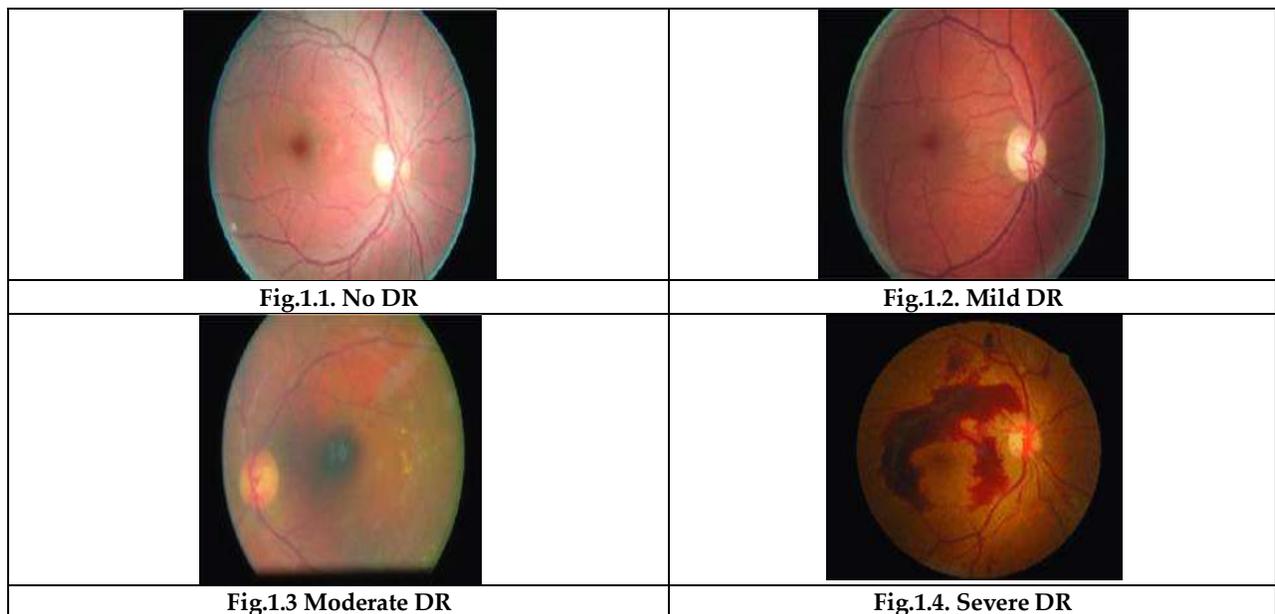
Venkat Narayana Rao *et al.,*
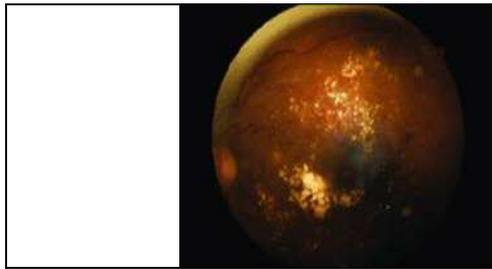
Fig.1.5 Proliferative	**Fig. 3. Architecture of the prospective regimen**
Fig. 4. Example of CNN	**Fig. 5.1 Training Results**
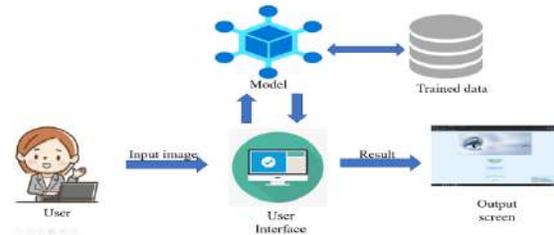
Fig. 5.2 Accuracy and test results

RESEARCH ARTICLE

Formulae for Iterative Sequence of Line Graph

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ABSTRACT

Based on certain well-known graphs, we look into some current trends on the line graph, along with some relevant line graph properties and traits. We started our work by discussing general terms about the line graphs of a few well-known graphs, such as the complete, bipartite, and regular graphs. Based on the fundamental ideas, we develop formulae for the degree, vertices and edges of the iterative line graph of these graphs. The demonstrated iterative formulas for the degree, vertices and edges of complete, bipartite, and regular graph's are important for building chains of related graph's line graphs. With the aid of some indicated findings and a list of iterative results, our work is justified. The iterative equations obtained will be useful for the algorithm on line graphs, in the context of graph practical and theoretical issues based on coloring and partitioning of a graph.

Keywords: phrases Complete, Bipartite, Regular, Iterative Line Graph, Line Graph

INTRODUCTION

The first mathematician to introduce graph theory was Euler [7], who did it in 1736. The study of graphical structure is known as graph theory in mathematics, and it is used to represent pair-wise interactions between objects. Mathematically graph $G = (V, E)$ is a collection of sets of points V known as vertices and a set of line E, joining points of V, known as edges. Order and graph size are determined by the number of vertices and edges, respectively. Graph $G's$ line graph $L(G)$ is a graph with its vertices as points, which are mapped by the edges of G. If two edges of G have a common vertex, then the two vertices of $L(G)$ that are mapped to those two edges of G are connected. Line graph has a rich history as of graph itself, come to a paper by Harary and Norman [6]. A

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book on graph theory by Harary [5] describes many results for line graphs. Though it was already used by Whitney [10], where he studied edges isomorphism, and by Krausz [11], who gives the first Characterization based on edge. Beineke theorem [3] for a simple graph to be a line graph is given by L.W. Beineke. Hassler Whitney[10] proved that a line graph is helpful to recover the structure of a graph G that is connected with one exceptional case. J. Bagga [2] studied the new and old generalizations of line graphs, which involve the concept of a super line graph. Till now, the various concepts of line graphs have been studied and there is a long list to specify its characteristics [5]. A book on line graphs and line diagraphs is available written by Beineke and J. Bagga [4] providing various information regarding line graphs and iterated line diagraphs and generalizations. A Singless Laplacian matrix of some special line graph is obtained by us to find the spectrum of them [12]. To utilize line graphs up to the required iterations we are presenting the main properties of line graphs and finding out some iterated formulae for our future prospects so that we can use them directly in algorithms. With a focus on complete, complete bipartite, and regular graph's line graph, the paper is organized into different sections; Section 2 provides the basics of line graphs of a few well-known graphs. We also derive and demonstrate the theorems related to the derivation of formulae for the edges and vertices of line graphs in this part. Section 3 of this article provides an introduction to iterative line graphs and derives iterative formulae for complete, complete bipartite, and regular graph's line graphs. With a justification of regularity, Section 4 implements our findings over well-known results.

2. 1ˢᵗ Iterative Line Graphs of Some Elementary Graph
We are providing here the elementary concepts of the line graph of some well-known graphs with some modification and implementation of previously proven results**.** Some important properties and theorems which are required to justify our work are described in this section.

2.1. Null Graph's 1ˢᵗ Iterative Line Graph
A graph type known as a null graph has zero degrees at each vertex. Since there are no edges in the null network, when we make a line graph of it, it is an empty graph on zero nodes.

2.2.Simple Graph's 1ˢᵗ Iterative Line Graph
The line graph that corresponds to a simple graph is also a simple graph.
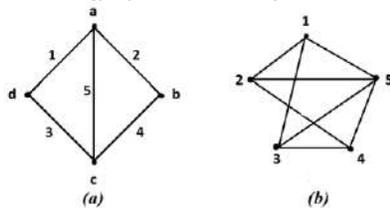
Figure 2.1 Simple Graph G and its L(G)

2.3.Complete Graph's Iˢᵗ Iterative Line Graph
A simple graph in which all of the vertices are connected to one another constitutes what is known as a complete graph, such a graph with n vertices is denoted by K_n. A Complete graph's line graph will be a regular graph as explained with the help of the following theorem.

Theorem 2.3.1 K_n's line graph will be $(2n-4)$ regular with $\dfrac{n*(n-1)}{2}$ vertices.

Proof- Consider a complete graph K_n, in this graph, the degree of each vertex will be $n-1$ and the edges associated with this vertex are connected to $n-2$ other edges from one end and $n-2$ other edges from the other end, which means in the line graph the vertex formed by these edges will connect to $(2n-4)$ vertices.

Also, we know that the size of K_n is $\dfrac{n*(n-1)}{2}$, that will be the order of K_n's line graph.

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Thus the K_n's line graph will be $(2n-4)$ regular with $\dfrac{n*(n-1)}{2}$ vertices.

Lemma 2.3.1 *The $\dfrac{n(n-1)(n-2)}{2}$ is size of K_n's line graph, where n is the order of K_n.*

Proof- If G is any graph of size $'e'$ and order $'n'$, then by handshaking Theorem [9] we have

$$\sum_{i=1}^{n} \deg(v_i) = 2e.$$

$$(2.1)$$

Also since K_n's the line graph is $(2n-4)$ regular with $\dfrac{n*(n-1)}{2}$ vertices (as mentioned in theorem 2.3.1).

So here using Equation (2.1), we get

$$2(n-2)*\frac{n*(n-1)}{2} = 2e.$$

$$(2.2)$$

Thus,

$$e = \frac{n(n-1)(n-2)}{2}.$$

$$(2.3)$$

Hence the size of K_n's line graph is $\dfrac{n(n-1)(n-2)}{2}$.

As per the observation of Theorem 2.3.1 and Lemma 2.3.1, the K_5's line graph will be a 6-regular graph of order 10 and size 30 as shown in Figure 2.2. Similarly, K_4's line graph will be a 4-regular graph of order 6 and size 12 as shown in Figure 2.3.
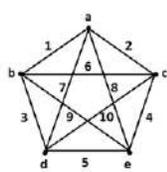
Figure 2.2 K_5 Graph and its $L(K_5)$ *Figure 2.3 K_4 Graph and its $L(K_4)$*
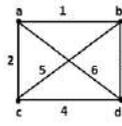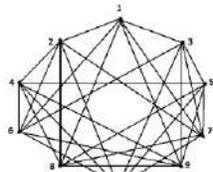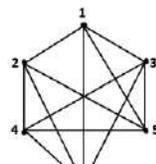
2.4. Complete Bipartite Graph's Iˢᵗ Iterative Line Graph

A complete bipartite graph $K_{m,n}$, is a simple graph such that the vertices set V can be partitioned like $V = A \cup B : A \cap B = \phi$, where A and B have m and n vertices respectively and all of the vertices in the set B are adjacent to all of the vertices of a set A. With the limitations that no two neighboring vertices are from the same set.

Theorem 2.4.1 *The complete bipartite graph's line graph $L(K_{m,n})$ is $m+n-2$ regular with order mn.*

Proof- As per the definition of a complete bipartite graph $K_{m,n}$ every n vertex of the first set is connected to every m vertex of the second set, so the edge joining a vertex of one set to another set is associated with $m-1$ edges from one end and $n-1$ edges from other ends, so in a line graph, the vertex corresponding to the edge is connected to $m+n-2$ other vertices so $L(K_{m,n})$ is $m+n-2$ regular.

Also, as the size of $K_{m,n}$ is mn the order of $L(K_{m,n})$ will be mn.

Lemma 2.4.1 *The counting of edges in $L(K_{m,n})$ is $\dfrac{m^2 n + mn^2 - 2mn}{2}$.*

Proof- The result is followed by the famous handshaking theorem.

As an example, a complete bipartite graph $K_{2,3}$ and its line graph as shown in Figure 2.4(a) and 2.4(b) respectively.
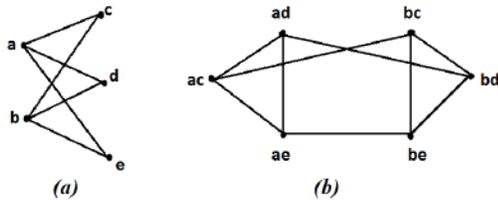
Figure 2.4 $K_{2,3}$ Graph and its $L(K_{2,3})$

As per our observation of Theorem 2.4.1 and Lemma 2.4.1, the $K_{2,3}$'s line graph 3-regular with 6 vertices and 9 edges as $m = 2$ and $n = 3$.

2.5. k – Regular Graph's Iˢᵗ iterative Line Graph

A k – regular graph is a simple graph having the degree of each vertex equal to k.

Theorem 2.5.1 *The order n and k – regular graph's line graph is a $2k - 2$ regular graph with $\dfrac{nk}{2}$ vertices and $\dfrac{nk(k-1)}{2}$ edges.*

Proof- As the size of order n and k – regular will be $\dfrac{nk}{2}$, thus the graph's line graph will have $\dfrac{nk}{2}$ vertices. As the network is of a regular graph, an edge linked to two neighboring vertices connects to $k - 1$ other edges from one end and $k - 1$ edges from the opposite end. Thus the line graph's vertex formed by this edge will connect to other $2k - 2$ vertices in the line graph, so the k – regular graph's line graph is $2k - 2$ regular.

And now by using the handshaking theorem, we can say the cardinality of the edge set in the line graph will be $\dfrac{nk(k-1)}{2}$.

By observation of Theorem 2.5.1, the 3-regular graph $G's$ line graph is 4-regular with 6 vertices and 12 edges as shown in Figure 2.5(a) and 2.5(b) respectively.
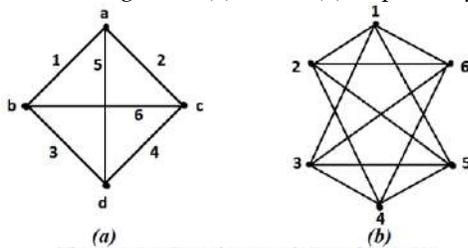
Figure 2.5 3-Regular Graph G and its L(G)

2.6. Complement Graph's Line Graph

In a complement graph H of G two vertices are connected if and only if they are not connected in G. In a complement, nodes are the same as G and the edges set consists of all the edges that are not in G. Here we show that the complement of some line graph. A complement of the line graph may be disconnected.

Figure 2.6 (a) shows; graph G its line graph 2.6(b) and the complement of line graph 2.6(c).

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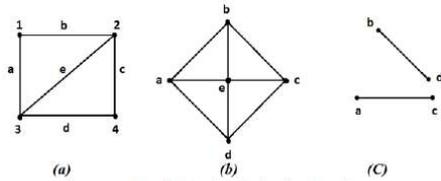
Figure 2.6 Graph G and L(G) then its Complement

The $K_5's$ line graph complement is a Petersen graph; with 10 vertices and 15 edges.

2.7 Graphs Complement's Line Graph
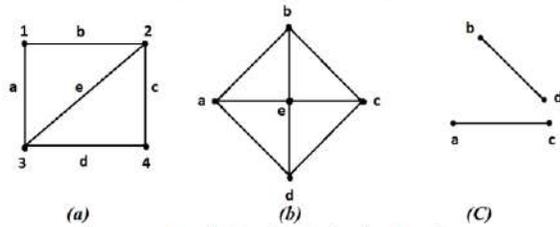
Figure 2.6 Graph G and L(G) then its Complement

Figure 2.7 (a) shows the graph G, 2.7(b) its complement G^c and 2.7(c) is G^c's line graph $L(G^c)$. In some graphs, the complement of a graph is disconnected then the line graph of this type of graph is disconnected. Since the complement of a full graph is a null graph, the line graph of a complement of a complete graph will also be a null graph.

3. Iterative Line Graphs

The graph $G's$ iterative line graph $L^i(G)$ defined as

$$L^i(G) = \begin{cases} G & : i = 0 \\ L\left(L^{i-1}(G)\right) & : i > 0 \end{cases}$$

Van Rooij and Wilf [8] considered the iterative sequence of a graph.

3.1 Iterative Formula for Complete Graph's Line Graph K_n

Using Theorem 2.3.1 and Lemma 2.3.1, we can say $L(K_n)$ will be $(2n-4)$ regular with $\dfrac{n(n-1)}{2}$ vertices and

$\dfrac{n(n-1)(n-2)}{2}$ edges, also using Theorem 2.5.1 line graph of a k – regular graph with n vertices will be $2k-2$

regular with $\dfrac{nk}{2}$ vertices and $\dfrac{nk(k-1)}{2}$ edges.

Combining the above two statements, we get

$L^2(K_n) = L(L(K_n)) = L(G),$ Where G is $2n-4$ regular with $\dfrac{n(n-1)}{2}$ vertices and $\dfrac{n(n-1)(n-2)}{2}$ edges. Using

Theorem 2.5.1 $L^2(K_n)$ will be $2(2n-4)-2 = 4n-10$ regular with $\dfrac{n(n-1)(n-2)}{2}$ vertices and

$\dfrac{n(n-1)(n-2)(2n-5)}{2}$ edges. Similarly, $L^3(K_n)$ will be $8n-22$ regular with $\dfrac{n(n-1)(n-2)(2n-5)}{2}$ vertices and

$\dfrac{n(n-1)(n-2)(2n-5)(4n-11)}{2}$ edges. Iteratively following this, we get a formula for $i > 3$, $L^i(K_n) = G$, where G

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will be $k^{(i)} = \left(2^i n - 2^{i+1} - \sum_{r=1}^{i-1} 2^{i-r} \right)$ regular graph having vertices $n^{(i)}$ given by Equation (3.1) and edges

$e^{(i)} = \dfrac{n^{(i)} k^{(i)}}{2}$ given by simplified equation (3.2) for direct use:

$$n^{(i)} = \frac{n(n-1)(n-2) \prod_{j=i}^{3} \left(2^{j-2} n - 2^{j-1} - \sum_{r=1}^{j-2} 2^{j-2-r} \right)}{2},$$

$$\text{(3.1)}$$

$$e^{(i)} = n(n-1)(n-2) \left(2^{i-2} n - 2^{i-1} - \sum_{r=1}^{i-1} 2^{i-2-r} \right) \prod_{j=i}^{3} \left(2^{j-2} n - 2^{j-1} - \sum_{r=1}^{j-2} 2^{j-2-r} \right)$$

$$\text{(3.2)}$$

The complete graph K_4 is having 4 vertices and 6 edges, then by the property 2.3 1ˢᵗ line graph of K_4 will be 4-regular with 6 vertices and 12 edges as shown in figure 3.1(b), and the 2ⁿᵈ iterative line graph of K_4 will be 6-regular with 12 vertices and 36 edges as shown in figure 3.1(c), 3ʳᵈ iterative line graph of K_4 will be 10- regular with 36 vertices and 180 edges as shown in figure 3.1(d), all these results are obtained by using equation (3.1) and equation (3.2).
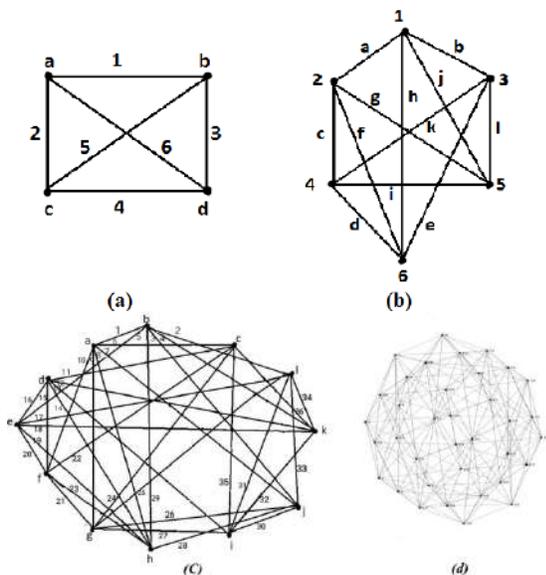
Figure 3.1 Graph K_4 and its $L(K_4)$, $L^2(K_4)$, $L^3(K_4)$

3.2 Iterative Formula for Complete Bipartite Graph's Line Graph $K_{m,n}$

By Theorem 2.4.1 and Lemma 2.4.1 we have, the complete bipartite graph's line graph $L(K_{m,n})$ will be $m+n-2$

regular of order mn and size $\dfrac{m^2 n + mn^2 - 2mn}{2}$. also using Theorem 2.5.1 we have, the order n, $k-$regular

graph's line graph will be $2k-2$ regular with $\dfrac{nk}{2}$ vertices and $\dfrac{nk(k-1)}{2}$ edges.

Combining these two statements, $L^2(K_{m,n}) = L(L(K_{m,n})) = L(G)$ where G is $m+n-2$ regular with mn vertices

and $\dfrac{mn(m+n-2)}{2}$ edges.

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Using Theorem 2.5.1 $L^2(K_{m,n})$ will be $2(m+n-2)-2=2m+2n-6$ regular with $\dfrac{mn(m+n-2)}{2}$ vertices and

$\dfrac{mn(m+n-2)(m+n-3)}{2}$ edges. Similarly, $L^3(K_{m,n})$ will be $4m+4n-14$ regular with $\dfrac{mn(m+n-2)(m+n-3)}{2}$

vertices and $\dfrac{mn(m+n-2)(m+n-3)(2m+2n-7)}{2}$ edges. Iteratively following this we get a formula for $i>3$,

$L^i(K_{m,n})=G,$ where G will be $k^{(i)}=\left(2^{i-1}m+2^{i-1}n-2^i-\displaystyle\sum_{r=1}^{i-1}2^{i-r}\right)$ regular graph having vertices $n^{(i)}$ given by

equation (3.3) and edges $e^{(i)}=\dfrac{n^{(i)}k^{(i)}}{2}$ given by simplified equation (3.4) for direct use:

$$n^{(i)}=\dfrac{mn(m+n-2)\displaystyle\prod_{j=i}^{3}\left(2^{j-3}m+2^{j-3}n-2^{j-2}-\displaystyle\sum_{r=1}^{j-2}2^{j-2-r}\right)}{2}.$$

(3.3)

$$e^{(i)}=mn(m+n-2)\left(2^{i-3}m+2^{i-3}n-2^{i-2}-\displaystyle\sum_{r=1}^{i-1}2^{i-2-r}\right)\displaystyle\prod_{j=i}^{3}\left(2^{j-3}m+2^{j-3}n-2^{j-2}-\displaystyle\sum_{r=1}^{j-2}2^{j-2-r}\right).$$

(3.4)

The given graph G is a complete bipartite graph $K_{6,2}$, with 8 vertices and 12 edges then by the property 2.4, its 1st line graph will be 6-regular with 12 vertices and 36 edges as shown in figure 9(b) and the 2nd iterative line graph will be 10-regular with 36 vertices and 180 edges shown in figure 9(c), these results are obtained by using equation (3.3) and equation (3.4). Figure 3.2 shows, a complete bipartite graph $K_{6,2}$ and the iterative sequence of the line graph.
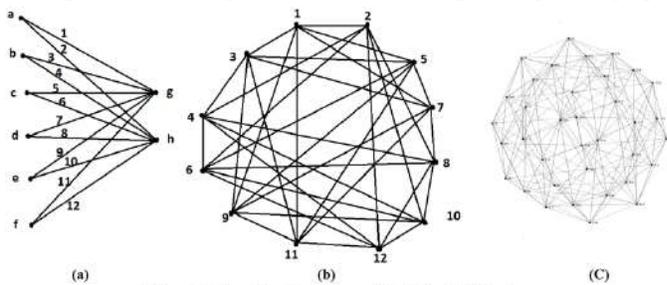
Figure 3.2 Complete Graph $K_{6,2}$ and its $L(K_{6,2})$, $L^2(K_{6,2})$

3.3 Iterative Formula for k -Regular Graph's Line Graph

By Theorem 2.5.1 we have, the order n, $k-$regular graph's line graph will be a $2k-2$ regular graph of order $\dfrac{nk}{2}$

and size $\dfrac{nk(k-1)}{2}$. Also, we know that the regular graph's line graph is again a regular graph and

$L^2(G)=L(L(G))=L(G')$ where G' is $2k-2$ regular graph with $\dfrac{nk}{2}$ vertices and $\dfrac{nk(k-1)}{2}$ edges then $L^2(G)$

will be $2(2k-2)-2=4k-6$ regular with $\dfrac{nk(k-1)}{2}$ vertices and $\dfrac{nk(k-1)(2k-3)}{2}$ edges. Similarly, $L^3(G)$ will

be $8k-14$ regular with $\dfrac{nk(k-1)(2k-3)}{2}$ vertices and $\dfrac{nk(k-1)(2k-3)(4k-7)}{2}$ edges. Iteratively following this

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we get a formula for $i > 3$, $L^i(G) = G'$, where G' will be a $k^{(i)} = \left(2^i k - 2^i - \sum_{r=1}^{i-1} 2^{i-r} \right)$ regular graph having vertices

$n^{(i)}$ given by Equation (3.5) and edges $e^{(i)} = \dfrac{n^{(i)}k^{(i)}}{2}$ given by simplified equation (3.6) for direct use:

$$n^{(i)} = \frac{nk(k-1)\prod_{j=i}^{3}\left(2^{j-2}k - 2^{j-2} - \sum_{r=1}^{j-2} 2^{j-2-r} \right)}{2},$$ (3.5)

$$e^{(i)} = nk(k-1)\left(2^{i-2}k - 2^{i-2} - \sum_{r=1}^{i-1} 2^{i-2-r} \right)\prod_{j=i}^{3}\left(2^{j-2}k - 2^{j-2} - \sum_{r=1}^{j-2} 2^{j-2-r} \right).$$ (3.6)

Consider a graph G that is 4-regular, with 6 vertices and 12 edges then by the property 2.5, its 1st line graph will be 6-regular with 12 vertices and 36 edges as shown in Figure 3.3(b), 2nd iterative line graph will be 10-regular with 36 edges and 180 edges as shown in Figure 3.3(c), all these results obtained by using Equation (3.5) and Equation (3.6). Figure 3.3 shows, a 4-regular graph and the iterative sequence of the line graph.
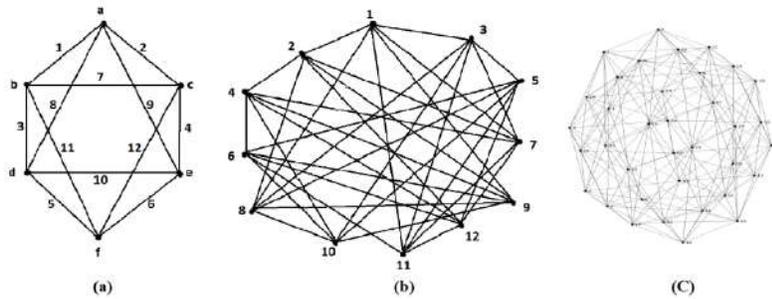
Figure 3.3 4-Regular Graph G and its L(G), L²(G)

4. Justification of Our Iterative Formulae Using the Implementation of Famous Results

Some essential properties of line graphs are as follows:

4.1. If G is a (p,q) graph whose degree sequence is $d_1, d_2, d_3,\ldots\ldots d_p$ and $L(G)$ is a (p',q') graph, then $p' = q$ and

$q' = \sum_{i=1}^{p} \binom{d_i}{2}$ first discovered by Whitney [10].

Example 4.1.
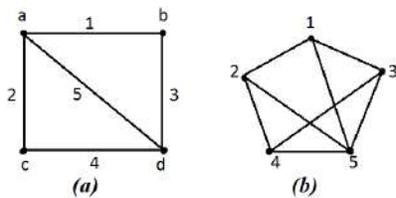
Figure 4.1 Graph G and its L(G)

As shown in Figure 4.1, a graph G is (4, 5) with degree sequence 3, 2, 2, 3 and $L(G)$ is (5,8) graph as $p' = 5$ and

$$q' = \sum_{i=1}^{p} \binom{d_i}{2} = \sum_{i=1}^{4} \binom{d_i}{2} = \binom{3}{2}+\binom{2}{2}+\binom{2}{2}+\binom{3}{2} = 3+1+1+3 = 8.$$

We can justify our Theorem 2.3.1 of a complete graph by Whitney's result,

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K_n is a graph $\left(n, \dfrac{n(n-1)}{2}\right)$ with a degree for each vertex $n-1$. According to Whitney's formula $L(K_n)$ is a graph

with order $\dfrac{n(n-1)}{2}$ and $\displaystyle\sum_{i=1}^{n}\binom{n-1}{2} = \dfrac{n(n-1)(n-2)}{2}$ edges, the same as we have proved in Lemma 2.3.1. Our result

gives a justification for regularity in addition to it.

Also if we consider a $k-$regular graph $\left(n, \dfrac{nk}{2}\right)$ i.e. a graph with n vertices having degree k. According to

Whitney's formula line graph of the $k-$regular graph will be a graph with $\dfrac{nk}{2}$ vertices and $\displaystyle\sum_{i=1}^{n}\binom{k}{2} = \dfrac{nk(k-1)}{2}$

edges, including the fact $2k-2$ regular, proved by Theorem 2.5.1.

Following the concept of regularity and using Whitney's result, we claim the justification of our iterative formulae.

4.2. As per Skiena if G is a graph of n nodes, e edges then a line graph of degrees d_i contains $n'=e$ nodes and

$e' = \dfrac{1}{2}\displaystyle\sum_{i=1}^{n}d_i^2 - e$ edges [9].

Example 4.2.
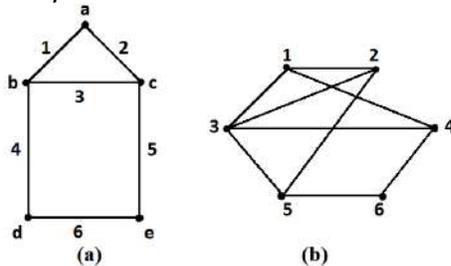
Figure 4.2 Graph G and its L(G)

As shown in Figure 4.2, a graph G with 5 nodes and 6 edges, then the line graph of degree of vertex 2, 3, 3, 2, 2

contain $n'=6$ nodes and $e' = \dfrac{1}{2}\displaystyle\sum_{i=1}^{5}d_i^2 - e = \dfrac{1}{2}(2^2 + 3^2 + 3^2 + 2^2 + 2^2) - 6 = 9$ edges.

Now by Theorem 2.3.1, a complete graph, K_n is $\left(n, \dfrac{n(n-1)}{2}\right)$ graph, then the line graph is a graph having a degree

of each vertex $n-1$ containing $n' = \dfrac{n(n-1)}{2}$ nodes and $e' = \dfrac{1}{2}\displaystyle\sum_{i=1}^{n}(n-1)^2 - \dfrac{n(n-1)}{2}$ edges.

Also, we have a $k-$regular graph $\left(n, \dfrac{nk}{2}\right)$, then the line graph is a graph having a degree of each vertex k

containing $n' = \dfrac{nk}{2}$ nodes and $e' = \dfrac{1}{2}\displaystyle\sum_{i=1}^{n}k^2 - \dfrac{nk}{2}$ edges. Thus this point 4.2 also justifies our results.

Our obtained iterative formulae of section 3, also satisfied the result provided by Whitney [10] and Skiena [9]. The

following Table 1 shows the vertices, edges, and regularity of the iterative sequence of line graph $L^i(G)$ of G for

the ith iteration, using our obtained iterative formulae as per the G, where G is as specified. From the above table,

we can justify our formulae as   is 3-regular and its 1st line graph is 4-regular with 6 vertices the result obtained for

its 2nd iteration is the same as the 1st iterative line graph of a 4-regular graph with 6 vertices and so on for successive

iteration. The same justification can be observed for a complete bipartite graph for the specified example in which the

considered complete bipartite graph's first line graph is 6 regular with 12 vertices as of 1st iteration of the considered regular graph and so the next obtained iterative results are the same.

CONCLUSION

In this paper, we have provided some deduction on a known line graph with iterative formulae of vertices, edges, and regularity of iterative sequence of complete, complete bipartite, and regular graph's line graph, starting with the basic concept of a line graph and covering several significant aspects. We also discuss how our formulae have been utilized in comparison to previously established outcomes, which supported our conclusion. We can now determine the line graph and corresponding Signless Laplacian matrix for any iteration using the formulae we obtained, allowing us to use them to practically construct specified coloring techniques.

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Table 1 : 1 shows the vertices, edges, and regularity of the iterative sequence of line graph $L^i(G)$ of G for the ith iteration, using our obtained iterative formulae as per the G , where G is as specified.

Graph G	Iteration: i^{th}	Vertices (n^i)	Edges (e^i)	Regularity (k^i)
Complete Graph $G = K_n$ **n=4**	1st	6	12	4
	2nd	12	36	6
	3rd	36	180	10
	4th	180	1620	18
	5th	1620	27540	34
Complete bipartite Graph $G = K_{m,n}$	1st	12	36	6

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m=6,n=2	2nd	36	180	10
	3rd	180	1620	18
	4th	1620	27540	34
	5th	27540	908820	66
k-regular Graph *G* *n=6,k=4*	1st	12	36	6
	2nd	36	180	10
	3rd	180	1620	18
	4th	1620	27540	34
	5th	27540	908820	66

REVIEW ARTICLE

Compartmental Model for Type 2 Diabetes - Examine the Impact of the Plasma Glucose-Insulin Regulation System

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ABSTRACT

A compartmental mathematical model describes the dynamics of the spread of Type-2 diabetes.The dynamical growth of the type 2 diabetes is depicted in a diagram as in Figure 1. Its investigation has been analyzed by using the observed equations from this diagram. Also a theoretical investigation of drug non-adherence is carried out hence forth.The stability analysis is used to examine a classification of the observed differential equations; under the provided criteria, the non-trivial significant point obtained is locally asymptotically compact. The MATLAB least-squares curve fitting technique, which is considered the mathematical model for the glucose tolerance test (GTT), is used to set the actual glucose data values. These approaches are used to compute the stable state distributions of diabetic subpopulations quantitatively. The findings indicate that, given a stringent diet and medication regimen, more than half of clinical diagnosis efforts are required to have a diagnosed population in addition to the undiagnosed.

Keywords: Diabetes, Plasma glucose, Plasma insulin, and interstitial insulin, non-adherence, and GTT model.

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INTRODUCTION

Diabetes is a disease characterized by the body's failure to produce insulin, which regulates blood sugar levels [1]. The study of diabetes can be considered at cell level. The glucose-insulin mathematical model gives a clear understanding of what take place in the blood stream glucose levels. Beta cells are the pancreas manufacture insulin in the blood stream. When beta cells die, the amount of insulin produced is reduced.Lack of physical activity and obesity are frequently responsible for this. Diabetes is also a habit; it develops in genetically susceptible persons and has become an epidemic [3]. Failure to control blood sugar levels causes extra problems. The exact cause of diabetes is unknown [4]. Alternative therapies can then be evaluated by comparing their respective performance measures, and the therapy with the maximal (or minimal) value of this criterion can thus be recommended [19].The body is approximated compartmentally. Then, the peripheral interactions out of the glucose dynamics,insulin dynamics and glucagon dynamics are described [12]. We chose the Sorensen model [30] as the base model and then estimated theSorensen model parameters using available clinical data obtained from type 2 diabetic subjects[21].

Mathematical Formulation
Compartmental Model
Comprehensive models present effective resources for comprehending, forecasting, and regulating various processes. The management of diabetic patients through adaptive model-based control includes the step-by-step fitting of a dynamic model to patient data. This process utilizes the "refined" model to calculate prospective insulin dosage regimens [12]. The insulin concentration in the interstitial fluid (ISF) of insulin-sensitive tissues plays a crucial role in stimulating glucose utilization [7]. Researchers have measured the concentration of interstitial insulin in human subcutaneous adipose tissue and skeletal muscle.

Diabetes has been depicted using a compartmental representation, wherein a human being's blood components consist of three elements [8]: Interstitial insulin action, plasma glucose, and plasma insulin [9]. These components are illustrated below in the diagram.
The differential equations relating the dynamics of Figure 1 are specified by

$$\overset{*}{G} = -X(t) - P_1 \tag{1}$$

$$\overset{*}{I}(t) = P_3 \tag{2}$$

$$\overset{*}{X}(t) = P_3 - P_2 \tag{3}$$

Substituting (3) in (1), we get

$$\overset{*}{G}(t) = P_2 - P_3 - P_1 \tag{4}$$

with the initial condition that $G(t_0) = G_0$, $X(t_0) = X_0$, $I(t_0) = I_0$ and $t \succ 0$

The total population is calculated as follows:
$$N = G + I + X$$

From the above figure 1, I is the plasma insulin level and I_b marks its basal stage; G is the plasma glucose level and represents its basal stage G_b. The combined differential equations for the glucose minimum model [11] are written as

$$\frac{dG}{dt} = -[X + p_1]G + p_1 G_b \tag{5}$$

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$$G_0 = G_b + \frac{D}{V}$$

$$\frac{dX}{dt} = -p_2 X + p_3 [I - I_b]; \qquad (6)$$

Comparing equation (4) and (5), we get

$$p_2 - p_3 - p_1 = -[X + p_1]G + p_1 G_b$$

$$[X + p_1]G = p_3 - p_2 + p_1[1 + G_b]$$

$$G = \frac{p_3 - p_2 + p_1(1 + G_b)}{(X + p_1)} \qquad (7)$$

Comparing equation (3) and (6), we get

$$p_3 - p_2 = -p_2 X(t) + p_3 I(t) - p_3 I_b$$

$$p_3 I(t) = p_3 - p_2 + p_2 X(t) + p_3 I_b$$

$$I = \frac{(1 + I_b)p_3 + (X - 1)p_2}{p_3} \qquad (8)$$

In these equations, $G(t_0) = G_0$ as well as $X = 0$. X, is the interstitial insulin at time t[30]. This model has four unknown parameters X, p_1, p_2 and p_3 all of which are defined with units and have brief descriptions below

Equations (7) and (8), with parameters p_1, p_2, p_3, $X(t)$, I_b and G_b generate illustrated equations and parameters for the nominal glucose metabolism model[20]. At the top are differential equations for glucose dynamics $G(t)$ in a mono-compartmental [13] "glucose space" and insulin dynamics in a "remote" compartment $X(t)$.Glucose vegetation grows at a rate proportional to the difference between plasma glucose $G(t)$ and the basal fasting glucose [6]level G_b.

In this model, t is the time; $G(t)$ is the plasma glucose concentration[32] at time t; G_b is the plasma insulin concentration at time t; $X(t)$ is the insulin concentration in the "remote" compartment at time t; G_b is the basal plasma glucose level; I_b is the basal plasma insulin level $G(0) = G_0$; p_1, p_1, p_3 and G_0 are unknown factors in the model that are uniquely identifiable from frequently sampled intravenous glucose tolerance tests; glucose effectiveness is p_1; and insulin sensitivity[14]is p_3.

Glucose Tolerance Test Model
The differential equation classification governing the GTT model can be expressed as follows:

$$\frac{dg}{dt} = -p_1 \cdot g - p_2 \cdot i + J \qquad (9)$$

$$\frac{di}{dt} = p_3 \cdot g - p_4 \cdot i \qquad (10)$$

Positive constants p_i $(i = 1,2,3,4)$; $g(t)$ is the difference between blood glucose absorption and $G(t)$ its baseline value G_0; J is the rate of glucose combination from the guts. As demonstrated in the following equations, $i(t)$ is the difference between plasma insulin absorption and $i(t)$ its baseline value I_0.

$$g = G - G_0 \quad\quad (11)$$

$$i = I - I_0 \quad\quad (12)$$

Where G and I are the parameters for blood glucose absorption, plasma insulin and p, a_1, a_2, a_3, a_4 are parameters. Using equations (11) and (12) in equations (9) and (10), we get

$$\frac{d(G - G_0)}{dt} = -p_1(G - G_0) - p_2(I - I_0) + J \quad\quad (13)$$

$$\frac{d(I - I_0)}{dt} = p_3(G - G_0) - p_4(I - I_0) \qu\quad (14)$$

Using Picard's Method of Iteration [25] for the above equations (11) and (12), we get

$$dG(t) - dG(t_0) = [-p_1(G - G_0) - p_2(I - I_0) + J]dt \qu\quad (15)$$

$$dI(t) - dI_0(t) = [p_3(G - G_0) - p_4(I - I_0)]dt \qu\quad (16)$$

Integrating on both sides, we get

$$G(t) = G_0 - \int_{t_0}^{t_1} [p_1(G - G_0) + p_2(I - I_0) - J]dt \qu\quad (17)$$

Similarly, we get

$$I(t) = I_0 - \int_{t_0}^{t} [p_3(G - G_0) + p_4(I - I_0)]dt \qu\quad (18)$$

From equations (11) and (12), we create a perturbation variable [27],

$g = G_0 - G_0$ and $i = I - I_0$

Where G_0 and I_0 are the symmetry values for blood glucose and insulin absorption[18], respectively.

Consequently,

$$f_1(G_0, I_0) = 0 , f_2(G_0, I_0) = 0 \qu\quad (19)$$

We develop the general model for linear expressions with these definitions and represent the linearized perturbation model [28] given by:

$$\frac{dg}{dt} = \frac{\partial f_1(G_0, I_0)}{dg} g + \frac{\partial f_2(G_0, I_0)}{di} i \qu\quad (20)$$

$$\frac{di}{dt} = \frac{\partial f_2(G_0, I_0)}{dg} g + \frac{\partial f_2(G_0, I_0)}{di} i \qu\quad (21)$$

Where g and i are represent the linearized perturbed variables.

Here f_1 and f_2 are the partial derivative functions. Where these functions are implicit is in the composition of glucose and insulin. As blood glucose levels rise, tissue glycogen uptake and storage in the liver are stimulated. Increases in insulin also enhance glucose uptake in tissues and the liver. As a result, it is apparent that

$$m_1 = -\frac{\partial f_1(G_0, I_0)_1}{dg}_1 < 0 \text{ and } m_2 = -\frac{\partial f_1(G_0, I_0)_1}{di} < 0 \qu\quad (22)$$

Increases in blood glucose cause the production of insulin, but increases in insulin just cause the metabolism of surplus insulin to increase [16, 22]. This data implies that

$$m_4 = \frac{\partial f_2(G_0, I_0)}{dg} > 0 \quad \text{and } m_3 = -\frac{\partial f_2(G_0, I_0)}{di} < 0 \qu\quad (23)$$

Stability Analysis

From the above results, we can write the linearized system [10] as follows:

$$\begin{pmatrix} \dot{g} \\ \dot{i} \end{pmatrix} = \begin{pmatrix} -m_1 & -m_2 \\ m_4 & -m_3 \end{pmatrix} \begin{pmatrix} g \\ i \end{pmatrix}$$

Where $\dot{g} = \dfrac{dg}{dt}$ and $\dot{i} = \dfrac{di}{dt}$

The linear system for these characteristic equations is given by:

$$\det \begin{vmatrix} -m_1 - \lambda & -m_2 \\ m_4 & -m_3 - \lambda \end{vmatrix} = 0 \qquad (23)$$

$$\lambda^2 + (m_1 + m_2)\lambda + m_1 m_3 + m_2 m_4 = 0$$

Here's $p(\lambda) = \lambda^2 + d_1\lambda + d_2$ where $d_1 = m_1 + m_2, d_2 = m_1 m_3 + m_2 m_4$ It's worth noting that the d_i's are all positive.

$$\lambda_1 = \frac{-(m_1 + m_2) + \sqrt{(m_1 + m_2)^2 - 4(m_1 m_3 + m_2 m_4)}}{2}$$

$$\lambda_2 = \frac{-(m_1 + m_2) - \sqrt{(m_1 + m_2)^2 - 4(m_1 m_3 + m_2 m_4)}}{2}$$

If $(m_1 + m_2)^2 > 4(m_1 m_3 + m_2 m_4)$, then $\sqrt{(m_1 + m_2)^2 - 4(m_1 m_3 + m_2 m_4)} < (m_1 + m_2)$. So that λ_1 and λ_2 are both negative.

If $(m_1 + m_2)^2 < 4(m_1 m_3 + m_2 m_4)$, then the equation $\sqrt{(m_1 + m_2)^2 - 4(m_1 m_3 + m_2 m_4)}$ must be is a complex quantity. Hence both λ_1 and λ_2 are both complex and negative real parts. Hence the model is stable around (0, 0).Hence the characteristic equation has positive coefficients by definition. The solutions to basic differential equations are either complex with a negative real portion or have both Eigen values that are negative real [21, 26]. As a result of this self-regulatory system, we attain a stable equilibrium in these situations.

Because of the GTT, we used to determine blood glucose levels, the complex Eigen values are the only linearized solution. The physiological response to a "sugar high" is what we think of (maximum of blood glucose), this is followed by a "sugar low" (a minimum of blood glucose below equilibrium) [24] that urges more eating after an hour or two. So here's the general solution:

$$g(t) = e^{-\alpha t}(c_1 \cos(\omega t) + c_2 \sin(\omega t)) \qquad (24)$$

Where $\alpha = \dfrac{m_1 + m_3}{2}$ and $\omega = \dfrac{1}{2}\sqrt{4(m_1 m_3 + m_2 m_4) - (m_1 + m_3)^2}$

If we take $c_1 = A\cos(\omega\delta)$ into account and $c_2 = A\sin(\omega\delta)$. Hence the blood glucose level of the above compartment is approximately as below:

$$G(t) = G_0 + Ae^{-\alpha t}\cos(\omega(t - \delta)) \qquad (25)$$

Here there are five parameters to be calculated from the above equation (which can be reduced to four by requiring that $g(0) = 0$.) The values of these parameters are calculated by the nonlinear least-square method [29]. If

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$G_1, G_2, G_3, \ldots\ldots, G_n$ are the patient's blood glucose concentration was measured at different times $t_1, t_2, t_3, \ldots, t_{n'}$ then we immediately find that the values $G_0, A, \alpha, c_1, c_2, \omega, \delta$ are to minimize the mean square error function:

$$E = \sum_{k=1}^{n} G_k - G_0 - Ae^{-\alpha t} \cos(\omega(t - \delta)) \quad (26)$$

It is worth noting that the requirement $c_1, c_2, c > 0$ implies that condition (24) is met.

Figure 1 depicts a three-dimensional phase portrait with a variety of initial conditions. We can see from the charts that all of the trajectories converge to the point (0, 0, 0). As a result, (0, 0, 0) represents a stable equilibrium point, and the model is globally stable .

Modeling with experimental data

The blood glucose level that our model predicts is fitted with a data set in this part, and key model parameters are computed. The data-set shows glucose Vs. time data for two individuals: Subject A, who is healthy and Subject B, who has diabetes. A data set from "Modeling Diabetes" was used by Joseph M.Mahaffy [21]

Figure 2 displays the confidence interval and best fit curve.Confidence intervals are statistical intervals created from a set of observable data [17]. The interval suggests that it may contain the parameter's actual value."

$G(t) \pm \sigma/\sqrt{N} \rightarrow$ Confidence interval" and "$\sigma \rightarrow$ standard deviation of data" are used synonymously in this context. The confidence interval narrows while confidence remains unchanged as N increases. The obtained parameters' values are G_b -the blood sugar level after a fast. ω -Angle of the frequency of the damped oscillator. Table 2 demonstrates that diabetics have lower values for both than do healthy people.

τ - The total amount of time required to lower blood glucose levels to their lowest feasible level is known as the digestive system's time constant for blood glucose reduction. According to Table 2, this parameter's value is essentially the same in diabetics and healthy people.

ω_0 -The natural angular frequency of the damped oscillator.

T_0 -The natural time period of the damped oscillator.

Here, the data set is shown, and Image 6 fits a function with confidence intervals. Subject A is normal, whereas subject B has mild diabetes, as shown by their respective values in Table 3 (2.3418% and 4.0569%). In light of this, it is evident that a person's score T_0 for determines whether or not they are pre-diabetic (for which $T_0 \approx 4.0 hours$) or not.

We determine the duration.The crucial interval $T_0 = 2\pi/\omega_c$ where $\omega_c^2 = \omega^2 + \alpha^2$ .According to Ackerman et al. [1] if $T_c < 4$ the person is normal, and if $T_c > 4$, then the person has diabetes. Now, two fictitious situations are considered: one compares a healthy individual to a Type-2 diabetic, and the other does the same for Type-1 diabetics. In terms of predicting the presence of pre-diabetes, this result is more reliable than the earlier model result. We also determined the value of an important parameter that was omitted from the earlier models. This measurement reveals how soon glucose reaches the bloodstream after leaving the digestive system [23]. Diabetes and blood sugar levels should never have an impact on this variable. As seen in Table 2, the value of is nearly the same for both healthy and diabetic persons, thus τ is therefore independent of diabetes and not dependent on blood glucose levels.

A simulated surface plot in three dimensions how T_0 varies with the range of α and ω is shown in Figure 3. Additionally, we observe that at a point, both falls α and ω increases significantly. High T_0 blood glucose levels that persist for an extended period of time are an indication of pre-diabetes.A three-dimensional simulated scatter plot is shown in Figure 4.Here, blue dots denote normal patients (for the indicated $T_0 < 4.0$ hours) and red dots denote pre-diabetic cases (for the indicated $T_0 \geq 4.0$ hours). This diagram demonstrates the existence of two entirely

distinct zones for healthy and diabetic individuals.It also demonstrates the wide variety of α and ω that might differ from person to person.

RESULTS AND DISCUSSIONS

The critical point is stable according to the stability analysis done in this study.This indicates that even when the system is disturbed or unsettled, it tends to this state.The two techniques for solving a linear system of equations were alternately utilized to calculate the steady state. The compartmental and GTT approaches are these techniques. The comparisons demonstrate that the Compartmental technique outperforms the GTT method in terms of accuracy. Compartmental technique's answer is more accurate than GTT method. Simulations are run to determine the impact of changing a few parameters on the variable, and the results are displayed as the aforementioned figures.

CONCLUSION

Consideration is given to the research of diabetes control brought on by drug use noncompliance. The stability study demonstrates that states are found using differential equation systems.The findings demonstrate the asymptotically stability of the equilibrium point.By taking the stability point into account, the outcome is stable. The compartmental model and the perturbation model were employed, and they were contrasted. According to the clinical diagnosis, managing diabetes is more than 90% effective. The clinical effort necessary to achieve the objective must be significantly increased when compared to the non-adherence method.The GTT model analysis effectively controls low-GI foods and medications, which is beneficial for diabetics. The results of the glucose tolerance test reveal whether the patient has diabetes or not.It is possible to effectively control blood sugar levels by using this way of computing the compartmental model by considering data collected over a long period of time.

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Table 1: Parameter and its units with explanation

p_1	$\min^{-1}$	The rate of net glucose utilization without dynamic insulin response, $p_1 = S_G$, is referred to as glucose effectiveness (i.e., insulin-independent)
p_2	$\min^{-1}$	The rate constant describes the natural decline in tissue glucose absorption capacity.
p_3	$\min^{-1}(\mu U / mL)^{-1}$	An increase in tissue glucose uptake ability that is insulin-dependent.
G_0	mg / dL	Theoretical glycemia at time 0 after the instantaneous glucose bolus.
$G(t)$	mg / dl	Plasma Glucose levels in the blood at time t
$I(t)$	U / ml	At time t, the blood insulin concentration is measured.
$X(t)$	$\min^{-1}$	The interstitial insulin at time t.

Table 2: Four blood glucose measurements and plasma insulin concentrations in two subjects (differences from baseline)

Time t	p_1	p_2	p_3	$X(t)$	I_b	G_b	$I(t)$	$G(t)$
1	0.013	0.07	0.009	2.5	5	85	17.6667	0.4206
2	0.018	0.02	0.002	3.2	8	92	31.0000	0.5146
3	0.020	0.04	0.009	4.1	10	78	24.7778	0.3760
4	0.011	0.05	0.012	3.9	6	105	19.0833	0.2884
5	0.015	0.04	0.008	3.7	4	97	18.5000	0.3871
6	0.017	0.03	0.002	4.0	12	81	57.9999	0.3401
7	0.013	0.03	0.006	3.8	7	110	22.0000	0.3721
8	0.025	0.05	0.017	3.5	9	89	10.7353	0.6723
9	0.011	0.05	0.016	3.3	11	93	19.1875	0.3020
10	0.012	0.03	0.005	3.6	3	75	19.6000	0.2456
11	0.015	0.05	0.008	3.9	13	102	32.1250	0.3839
12	0.014	0.03	0.009	3.7	5.5	87	15.5000	0.3261

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Table 3: The GTT findings are displayed in Subject A, a typical person. Diabetes affects Subject B.

t (hr)	Subject A	Subject B
0	70	100
0.5	150	185
0.75	165	210
1	145	220
1.5	90	195
2	75	175
2.5	65	105
3	75	100
4	80	85
6	75	100

Table 4: Values of the fit parameters

Subject	G_b	α	ω	C_0	τ in hours
A	78.8161	1.1733	2.4128	116.4327	0.6447
B	94.4838	0.8685	1.2823	208.3634	0.6242

Table 5: Values of main parameters ω_0 **and** T_0

Subject	α	ω	$\omega_0 = \sqrt{\omega^2 + \alpha^2}$	$T_0 = \dfrac{2\pi}{\omega_0}$ in hours
A	1.1733	2.4128	2.6829	2,3418
B	0.8685	1.2823	1.5487	4.0569
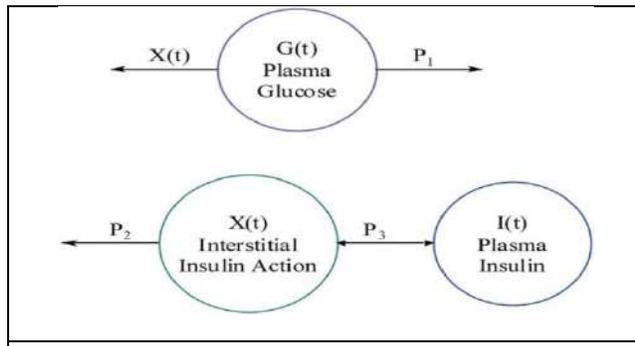
Fig. 1:The compartmental flow chart of the glucose kinetics minimal model[12]	**Fig 2. These model's phase pictures reveal that it is globally stable (0, 0, 0) point is shown in the plots as red (x).**
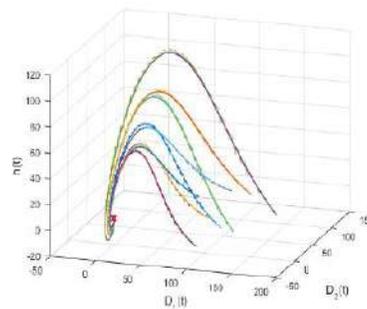
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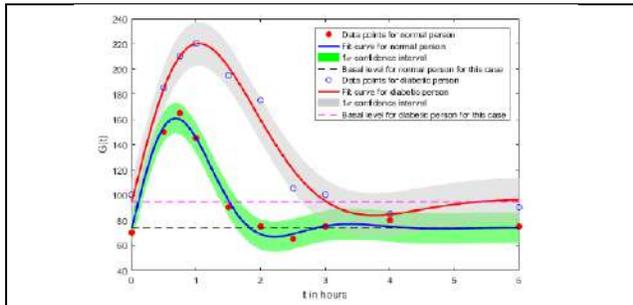
Fig. 3: Fitted curve for individuals with and without diabetes, with interval	Fig. 4: Surface plots in three dimensions that differ in α and ω
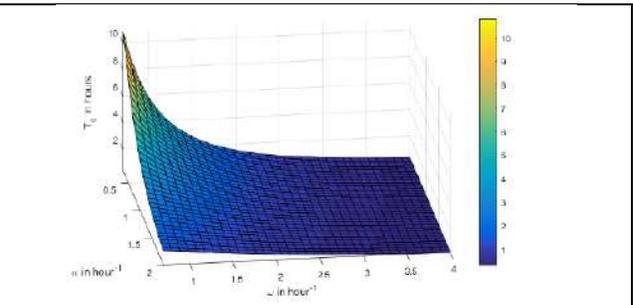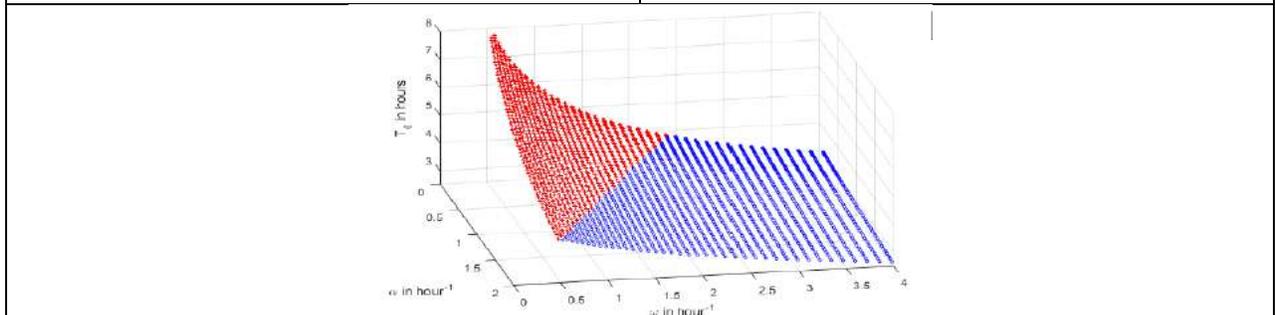
Fig. 5. simulated scatter plot in three dimensions

RESEARCH ARTICLE

Development of TABEC Poly herbal Formation for the Treatment of Ulcer

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ABSTRACT

An ulcer is erosion in the lining of the stomach or duodenum. It is caused by disruption of the gastric mucosal defense and repair systems. Peptic ulcer is a widespread health disorder today. Plant-derived compounds have been used as drugs, either in their original or semi-synthetic form. Recent studies shows that there has been much interest in natural approaches towards medication derived from traditional knowledge of the pharmacological properties of plants and attempts have been made to know about the effects of poly herbal formulation in the treatment or prevention of ulcers and their phyto chemical characterization. In this present study, the TABEC poly herbal formulation was prepared using *Enicostemma littorale* Blume, *Terminalia chebula,* and *Caesalpinia bonducella* species using a cold extraction method and their phytochemical characterization was performed using a qualitative method. The anti-ulcer activity of the poly herbal formulation was analyzed using the acid neutralization method. The results showed that the polyherbal formulation exhibited maximum anti-ulcer activity at the concentration of 500 μg/ml with 3.6 g/ml of acid-neutralizing capacity. The phytochemical characterization results showed that the presence of resin, carboxylic acids, flavonoids and proteins. Taken together, these results showed that the poly herbal extract can be used for the treatment of various peptic ulcers.

Keywords: Ulcer, medical plants, traditional medicine, acid neutralization

INTRODUCTION

Peptic ulcer disease includes both gastric and duodenal ulcers which posed a major threat to the world's population over the past two centuries. An ulcer is defined as disruption of the mucosal integrity of the stomach and duodenum leading to a local defect or excavation due to active inflammation.[1] PUD results when "aggressive" factors (gastric acid, pepsin) overwhelm "defensive" factors involved in mucosal resistance (gastric mucus, bicarbonate, microcirculation, prostaglandins, mucosal "barrier"), and also from effects of *Helicobacter pylori*. *H. pylori* is invariably associated with histologic evidence of active chronic gastritis, which over years can lead to atrophic gastritis and gastric cancer. *H. pylori* causes an inflammatory response with neutrophils, lymphocytes, plasma cells, and macrophages within the mucosal layer and causes epithelial cell degeneration and injury [2]. The other major cause of ulcers is nonsteroidal anti-inflammatory drugs (NSAIDs). Other risk factors include alcohol consumption, tobacco smoking, psychological stress, some hereditary conditions [3]. Several drugs have been manufactured to combat this disorder. Some orthodox drugs employed in the treatment of this disorder include histamine (H2) receptor antagonists, proton pump inhibitors, cytoprotectants, antacids, and prostaglandin analogues [4,5]. Most of these drugs are costly and have intolerable side effects when taken. Many shreds of evidence stipulate the influential role of herbal plants in conferring antiulcer properties and thus we switch to prospective medicinal plants to treat peptic ulcer diseases. The Ayurvedic literature *Sarangdhar Samhita*' highlighted the concept of poly herbalism to achieve greater therapeutic efficacy. The active phytochemical constituents of individual plants when combined with multiple herbs in a particular ratio, will give a better therapeutic effect and reduce the toxicity [6].

Enicostemma littorale plays a vital role in human healthcare. The plant parts such as leaves and roots were used in traditional practice for treating several ailments like malaria, skin diseases, leprosy, diabetes, abdominal ulcers, rheumatism, hernia, itches, insect poisoning, and swelling etc. The leaf possesses hypoglycemic, antioxidant, hepatoprotective, and hepatomodulatory properties and helps in reducing obesity. [7,8] The aerial parts of *E. littorale* against aspirin, ethanol, and pyloric ligation induced ulcers in rats and bovine serum albumin (BSA) denaturation was examined for antiulcer and anti-inflammatory effects by Roy *et al*.,[9] It was reported that the methanolic extract of *E. littorale* possesses antiulcer activity. *Terminalia chebula* is called the "king of medicines" and is always listed first in the Ayurvedic Materia medica because of its extraordinary powers of healing.[10] The anti-ulcer activity of ethanolic extract of *Terminalia belerica* (Combretaceae) fruits ETB was investigated in pylorus ligation and ethanol-induced ulcer models in Wistar rats and the extract showed a significant reduction in free acidity and ulcer index as compared to the control.[11. *Caesalpinia bonducella L.* is a medicinal plant belonging to the family Caesalpiniaceae. The existence of saponins, alkaloids, triterpenes, flavonoids, steroids, and tannins was detected in the aqueous extract of CBD and it was found that flavonoids possessed anti-ulcer activity. The methanolic extract of *C.bonducella* (Linn.) Flem. leaves have considerable anti-ulcer activity [12]. Therefore, the present study was aimed at evaluating the antiulcer activity of the polyherbal formulation containing the extracts of *Caesalpinia bondue*, *Termimalia chebula* and *Enicostema auillare.*

MATERIALS AND MEHODS

Sample collection
Caesalpinia bondue, *Termimalia chebula* and *Enicostema auillare* were collected from Mathur, Pudukottai district. Tamil Nadu. (10.7271° N, 78.5860° E).

Cold extraction of poly herbal formulation
The composition of poly herbal formulation was prepared for this study is *Caesalpinia bondue* - 15 gm, *Termimalia chebula* - 20 gm, *Enicostema auillare* – 15 gm. The powdered materials (three different plant samples) 10 gm and add 100ml Ethyl acetate dissolved the *materials* incubated at 4°C for further investigation. The powdered poly herbal

material was immersed in 100 ml of ethanol and the extract was separated by Muslin cloth and filtered by Whatman No.1 filter paper and dried by rotary evaporator.

Phyto chemical Screening

Phyto chemicals are nonnutritive plant chemicals that contain protective, disease preventing compounds. Standard screening test were carried out for various plant constituents. Hydro-methanolic crude extract were screened for their presence or absence of secondary metabolites such as alkaloids, steroids, phenols, resins, tannis, proteins, glycosides, carboxylic acid, flavonoids etc. using standard procedures.

Antiulcer activity

The acid neutralizing capacity of the solution mixture at different concentrations (500, 250, 100, 50 and 10 μg/ml) was compared with the standard antacid Aluminium hydroxide + Magnesium hydroxide (50 mg/ml). 5ml of the standard was taken and water was added to make up the total volume to 70 ml and then mixed for one minute. Then 30 ml of 1.0 N HCl was added into standard and test preparation and stirred for 15 minutes, drops of phenolphthalein solution was added and mixed. The excess HCl was immediately titrated with 0.5 N Sodium hydroxide solution drop wise until a pink color is attained.

Determination of acid neutrilizing capacity

Moles of acid neutralized = (vol. of HCl ×Normality of HCl) - (vol. Of NaOH × Normality of NaOH)

$$\text{Acid neutralizing capacity (ANC) per gram of antacid} = \frac{\text{moles of HCl neutralized}}{\text{Grams of Antacid/Extract}}$$

DPPH Radical scavenging assay

Free radical scavenging ability of the extracts was tested by DPPH radical scavenging assay Radical scavenging activities are very important to prevent the deleterious role of free radicals in different diseases, including cancer. DPPH free radical scavenging is an accepted mechanism for screening the antioxidant activity of plant extracts. The hydrogen atom donating ability of the plant extractives was determined by the decolorization of methanol solution of 2,2-diphenyl-1-picrylhydrazyl (DPPH). DPPH produces violet/purple color in methanol solution and fades to shades of yellow color in the presence of antioxidants [13]. 0.1 mM DPPH solution was prepared by dissolving 39mg of DPPH in 100ml of methanol and stored at -20º C. A standard ascorbic acid was prepared (1mg/ml). Add 100 μl of the DPPH solution to 300 μl of the sample at different concentrations (500, 250, 100, 50, 10 μg/mL). Mix it thoroughly and allow it to stand at room temperature for 30 minutes. The absorbance of the mixture was measured spectro photometrically at 517 nm with ascorbic acid as reference. Lower absorbance values of reaction mixture indicate higher free radical scavenging activity. Percentage DPPH radical scavenging activity was calculated by the following equation:

DPPH scavenging effect (% inhibition) = [(absorbance of control- absorbance of reaction mixture)/absorbance of control] X 100.

RESULTS AND DISCUSSION

Peptic ulcers are a broad term that includes ulcers of digestive tract in the stomach or the duodenum. The formation of peptic ulcer depends on the presence of acid and peptic activity in gastric juice plus a breakdown of mucosal defenses. A number of synthetic drugs are available to treat ulcers. But these drugs are expensive and are likely to produce more side effects when compared to herbal medicines. The therapeutic potential of herbs or medicinal plants come from its phyto chemical constituents. In the present study, phyto chemical characterization, anti-ulcer activity of poly herbal formulation extract was carried out. The phyto chemical screening of has shown the presence of many biologically active chemical compounds such as proteins, flavonoids, resin and carboxylic acid. By studying the presence of phyto chemical in poly herbal formulation, the medicinal value of the plant can be explained scientifically. The phyto chemical screening of extracts showed the presence of major derivatives. As shown in table .1 the phyto chemical analysis showed the occurrence of proteins, flavonoids, phenol, resin and carboxylic acid in hydro alcoholic extracts. Furthermore, proteins, flavonoids, resin and carboxylic acids in various plants extracts

proven to be effective antimicrobials. Our results are also in agreement with these studies suggesting the efficacy of alcoholic extract of poly herbal formulation against phytochemical test. Another analysis by Ahameethunisa *et al(20).* have shown the presence of major chemical compounds such as proteins, flavonoids, resin and carboxylic acid. Biological activity was detected in a series of compounds were responsible for biological activity. The leaves have been widely used to prepare concentrates and powders for restorative uses (21). Bioactive compounds are known for their antitoxin resistance and as a reliable source of antimicrobial treatments, and are widely used as anti-infective supplements and adjuncts in combination with other compounds (22). Ulceration occurs when there is a disturbance of the normal eguilibirium caused by either enhanced aggression or diminished mucosal resistance. In the present study, the TABEC poly herbal formulation showed the maximum acid neutralizing capacity at the concentration of 500mg/ml were shown in figure 3. Pandian et al reported that the invivo method as the acid neutralizing capacity, the extract significantly reduced ANC to 9.33 at a concentration of 1500mg as compared to 15.7 with standard aluminium hydroxide and magnesium hydroxide. (500 mg)**.** Similarly, the antioxidant activity of TABEC poly herbal formulation was carried out by DPPH method. Antioxidants have the ability to protect organisms from damage caused by free radical induced oxidative stress. A lot of research is being carried out worldwide directed toward finding natural antioxidants of plant orgin (23). The antioxidant activity of the TABEC poly herbal formulation showed the concentration dependent inhibition of free radical scavenging activity. The maximum antioxidant activity was observed was observed at the concentration of 500mg/ml and the percentage of inhibition was found to be 93.12%. Chandra Sekar et.al., reported that the alcoholic plant extract showed IC 50 value of 24.8 µg/ml.(Table.2) Similarly, the dose dependent inhibition curve and IC 50 concentration of the TABEC poly herbal formulation was found to be 57 µg/ml.(table.3) Taken together, these results confirms that the TABEC poly herbal formulation is rich in antioxidant and anti-ulcer capacity and can be used for the various ulcer disease.

CONCLUSION

An ulcer in the GI tract can be defined as a 5 mm or larger break in the lining of the mucosa, with appreciable depth at endoscopy or with histologic evidence of sub mucosal extension. [14]. Treatment is usually directed at identifying the factors that lead to PUD. For *H. pylori*-associated PUD, eradication alone will lead to ulcer healing and prevent further mucosal injury. However, due to rising antibiotic resistance in *H. pylori*, treatment has become more difficult. There have been issues with the cost and availability of other medicines. Moreover, in the past few years, there has been a rising interest in alternative therapies and the usage of herbal products, in particular, those produced from medicinal plants [15, 16]. Phyto therapy is a primeval practice to fight various diseases and disorders. Plant extracts and their crude are the most significant sources of new drugs, and have been shown to cause promising results in the treatment of gastric ulcer as well [17]. It is known that numerous pharmaceutical agents such as proton pump inhibitors, antacids, antimicrobial agents, H2-receptor antagonists, sucralfate, and bismuth are not fully effective, and produce numerous adverse effects and are cytotoxic [18,19]. Therefore, we turn towards phyto therapy for effective and safe drugs with gastroprotective activity. Especially, plants with antioxidant capability as the main mechanism are used as the herbal reservoir for the treatment of ulcer disease [19]. *Caesalpinia bondue*, *Termimalia chebula* and *Enicostema auillare* are found extensively in India. These plants manifest anti- inflammatory, antifungal, antimicrobial, antiulcer, anti-filarial, anticancer and antioxidant activity. They are an important source of various phyto chemicals with pharmaceutical potentials. The therapeutic potential of these medicinal plants is due to its phyto chemical constituents. In the present study, phyto chemical characterization and anti-ulcer activity of the poly herbal formulation was experimented. By studying the presence of phyto chemicals in the poly herbal formulation, the efficiency of the medicinal value in plants can be determined ideally and could be further used as an alternative therapy to treat ulcers. The phyto chemical screening of extracts showed the presence of major derivatives that includes proteins, flavonoids, phenol, resin and carboxylic acid in hydro alcoholic extracts. Furthermore, proteins, flavonoids, resin and carboxylic acids in various plants extracts are proven to be effective antimicrobials. Bioactive compounds are known for their antitoxin resistance and as a reliable source in antimicrobial treatments, and are widely used as anti-infective supplements and adjuncts in combination with other compounds. Our results are also in agreement with these studies proclaiming the efficacy of alcoholic extract of poly herbal formulation.

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The TABEC poly herbal formulation evinced antiulcer and antioxidant properties and that it could be a ''lead'' for the isolation of novel agent with good efficacy to treat various diseases and disorders of the gastrointestinal tract. Henceforth, in vivo experiments should be incited using the TABEC poly herbal formulation due to its high potency. Furthermore, the development of such natural antiulcer drugs will help to decrease the negative effects of synthetic drugs.

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Table-1: phyto chemical screening of poly herbal formulation

S. No	Phyto chemical compound	Name of the Sample	Result
1	Resins		+
2	Carboxylic acid		+
3	Tannins		-
4	Steroids		-
5	Flavanoids		+
6	Carbohydrates		–
7	Glycosides		–
8	Saponification	TABEC poly herbal formulation	-
9	Proteins		+
10	Phenol		+
11	Biuret		–
12	Saponin		–
13	Gum		–
14	Flavanoglycoside		–
	Alkaloids		–

Table-2 Percentage of Inhibition.

S. No	Tested sample concentration (µg/ml)	Percentage of inhibition (in triplicates)			Mean value (%)
1.	Ascorbic acid	84.21	89.13	89.39	87.58
2.	500 µg/ml	94.62	93.21	91.54	93.12
3.	250 µg/ml	90.46	92.84	93.83	92.37
4.	100 µg/ml	90.64	89.65	90.46	90.25
5.	50 µg/ml	89.00	84.05	93.99	89.01
6.	10 µg/ml	92.57	70.55	94.64	85.92

Table-3 IC_{50} Value of tested sample: 57.54 µg/ml

Best-fit values		
LogIC50		1.760
HillSlope		-1.835
IC_{50}		57.54
Std. Error		
Log IC_{50}		0.3885
HillSlope		3.268
95% Confidence Intervals		
LogIC50		0.9208 to 2.599
HillSlope		-8.895 to 5.224
IC_{50}		8.333 to 397.3
Goodness of Fit		
Degrees of Freedom		13
R square		0.1714
Absolute Sum of Squares		98836
Sy.x		87.19
Number of points		
Analyzed	3	15

Figure:1-a. Enicostema auillare

Figure1-b. Termimalia chebula

Figure 1-C. Caesalpinia bondue

Figure:2-TABEC Polyherbal Powder

Figure:3. Images for qualitative phyto chemical screening of poly herbal formulation

Figure 4. Antioxidant activity of TABEC poly herbal formulation by DPPH method

Graph 1: Results of TABEC poly herbal formulation acid neutralization activity.

Graph 1: Results of TABEC poly herbal formulation of DPPH assay.

RESEARCH ARTICLE

The Digitalization of Education Supports Online Teaching and Learning Methodologies

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ABSTRACT

To stay competitive, many institutions of higher education are now embracing digital transformation. Why? Because there are so many educational options available to students today, and because institutions need to adapt to growing consumer and environmental challenges by becoming more flexible, inexpensive, and accessible. Institutions may improve their teaching and learning, as well as their ability to successfully manage their operations, thanks to the exciting possibilities and opportunities offered by the digital transformation -all of which are essential to better serving students. Despite this, a large number of schools and universities are either not digitizing at all or are only partially successful in their efforts. As a result, their technology spending is increasing, but there is return on their investments. The areas of digital transformation in the educational system supports online teaching and learning methodologies are the main topics of this article.

Keywords: Teaching and learning, Digital transformation Digital learning, Collaborative learning, Online learning.

INTRODUCTION

It's helpful to first construct a workable definition in order to invest in digital transformation initiatives that deliver real advantages on strategic, operational, and financial goals. Higher education's use of digital technologies and commercial models to implement organizational changes with the goal of enhancing an institution's operational performance is known as "digital transformation." In order to better serve clients and expedite business operations, the entire business model is being transformed using digital technology.

Examples of Digital Transformations in Education Include

✦ Increasing the use of digital platforms and tools, such as websites, social media, Chabot's, and email marketing, to attract and keep students.

✦ Gathering, linking, and activating campus-wide data to help guide decisions.

✦ Providing self-service capabilities so that students may conduct tasks like class registration, transcript requests, and financial aid requests on their own.

✦ Automating cross-departmental operations to do jobs more quickly and precisely.

Students' high expectations and preferences for digital services are no longer limited to the world of business. Students now carry same expectations of ease, personalisation, self-service, automation, and customer service to their educational experience because most other sectors engage with consumers digitally. Institutions need to embrace and speed up the digital transformation process if they want to succeed in the future. This will help them to run more efficiently, cut costs, enhance student experiences, and reach a wider audience.

According to the global declaration on higher education in the twenty-first century, students' critical thinking and creativity grow through the use of new teaching techniques. To motivate kids to learn, innovative teaching methods and educational advances are needed. The teaching-learning process has three vertices: teaching, communication technology through digital tools, and new teaching techniques. The teacher serves as a facilitator in the first vertex, assisting students in the acquisition of new knowledge and abilities by giving them access to resources and tools. By focusing on certain subjects, project-based learning supports collaborative learning among teachers and students. Students learn to be independent thinkers. Teachers must constantly innovate if they are to support global learning. When university researchers and instructors are allowed opportunity to develop innovative educational learning. The government's activities concentrate on online mode as a choice in a post-Covid environment. Educators are trusted to lead the way as the world changes and are actively involved in the shift, according to a renowned learning experience design consultant. Weiss points out that a teacher needs to spice up the lessons.

Construction of a digital transformation Framework for Digital Education Learning

As university professors and researchers in educational technology, we have observed digital transformation (Dx) in educational institutions. We offer a framework designed to effectively incorporate digital technology into learning environments. Vial asserts that structural adjustments in four areas organizational structure, organizational culture, leadership, employee roles, and skills are essential for Dx. Each of these four areas is covered by seven aspects of the Dx framework for digital learning in education: instructional modality, personnel and support services, organizational policies and planning, instructor development, learner development, partnerships, and digital learning technologies (see figure 1). There may be some colleges and universities that are already in the middle of Dx and others that are just beginning.

Technologies for Digital Learning

Digital technologies, which are fundamental to digital teaching and learning, are the foundation of Dx. To engage students, a variety of educational styles might leverage digital technologies. These technologies can be used by teachers to create interactive online teaching and learning programs. However, higher education institutions that effectively use digital teaching and learning must significantly upgrade their infrastructure. The following is a description of several popular digital teaching and learning tools. Learning management systems (LMS).

➢ **Technologies that work in sync:** Online meetings in real-time are conducted using synchronized technologies. Various functionalities, including as audio and video, text/chat, screen sharing, polls, whiteboards, and breakout rooms for small group discussions are all included in synchronous technology. These features can assist teachers in maintaining interaction in online classrooms, Multimedia programs. Audio, video, and other interactive components are all part of multimedia, which can hold students' attention. Micro-lectures, demonstrations, orientations, and other events can all be recorded using multimedia software. Open access software for multimedia exists. Applications that are more capable must be acquired. For simple access and use, some multimedia programs

can also be incorporated within the LMS. Collaborative applications. Students can work online with their peers and teachers using web-based or cloud-based word processing, presentation, social engagement, and whiteboard apps.

➢ **Technology based on the cloud**: Universities and colleges use a variety of cloud-based apps. Some academic staff members utilize cloud-based software to store data so they can access them from any location and are not limited to their desk computers.

➢ **Cutting-edge technologies** Emerging technologies like artificial intelligence (AI), extended reality (XR), augmented reality (AR), virtual reality (VR), analytics, and others can make teaching and learning more creative and interesting. The technologies that can be utilized for digital teaching and learning are not all listed here. Before acquiring a technology for their campuses, technology leaders must assess its results and take into account its price and quality. Technology executives should assess their infrastructure to make sure it is suitable for online instruction and learning.

Pedagogical Method

A variety of instructional modes can be used to deliver education. Students can enroll in the learning mode that best suits them when a college or university provides courses in many learning modalities. The list of typical teaching modalities is shown below.

❖ Improved technologies on-campus. This modality combines in-person instruction with the use of technology to improve learning.
❖ Blended or hybrid. This teaching method combines classroom instruction with online learning to give students the option of both on-campus and distance learning.
❖ Online asynchronous. This mode of instruction eliminates in-person encounters in favour of online interactions.
❖ Online synchronization. Real-time online instruction and learning take place in this format.

➢ **Online Bichronous**: This teaching and learning approach combines synchronous and asynchronous online activities. The synchronous sessions are attended in real time, and the asynchronous classes are attended at the student's convenience.
➢ **The HyFlex**: The maximum flexibility is provided by this technique. Online and in-person students are both present in the same classroom. Learning is to blended/hybrid learning, yet it permits.
Services for personnel and support: Universities and colleges must make additional investments in support services and staff as a result of the increased popularity of digital teaching and learning across a range of instructional modalities. The following lists some of the personnel and support services required for a successful digital transformation of teaching and learning.
➢ **Educational architects:** In comparison to previous years, higher education institutions are hiring more instructional designers and technology professionals. The skill of instructional designers in creating digital learning experiences is increasingly understood and valued by administrators and teachers. To create engaging courses for multiple modalities, instructional designers collaborate with instructors.
➢ **Experts in technology assistance:** If a school expands its digital teaching and learning offerings, more employees will be required to maintain networks and equipment. Though most campuses currently have some level of technology support, the rise of digital teaching and learning has led to a demand for 24-hour technological help for both students and teachers. According to research, instructors are interested in obtaining a variety of supports, such as individualized and just-in-time support.
➢ **Support services for students and academics:** Students require academic help in order to use the writing centers and library services. Digital teaching and learning also require student support services (registration, academic advising, study skills consultations, etc). Students with special needs should also have access to resources that can help them with online education.
➢ **Incentives and acknowledgement:** Faculty who are innovators in digital teaching should be commended and given incentives. Faculty members have the chance and time to investigate and incorporate digital innovations into their courses thanks to financial incentives and course release time.

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The adoption of cutting-edge digital teaching methods by instructors is encouraged by support, services, incentives, and recognition.

Planning and organizational policies: As part of any Dx initiative, administrators must be prepared to supervise digital teaching and learning initiatives and advance uniform teaching and learning across all subject areas. Leaders should continue to apply research-based methods in all decision-making processes, including tenure and promotions, and place a strong emphasis on developments in digital teaching and learning.

➤ **Standards and regulations:** For digital teaching and learning, institutional norms and standards need to be established. A variety of policies, including teaching load, enrolment requirements, and performance and evaluation standards, must be taken into account by administrators. To evaluate digital education, for instance, new course evaluation tools need be developed or modified.

➤ **Planning strategically:** According to Business Dictionary, strategic planning is "the process of defining a strategy as well as deciding on the resources that are allocated to pursue a strategy in order to achieve firms' goals. "In order to win faculty support, administrators must incorporate Dx into their strategic planning.

➤ **Financing schemes:** Administrators must to look at various modalities' funding models. Since students do not need to be on campus or pay for on-campus services when taking an online course, universities can charge alternative tuition rates.

➤ **Fair chances for education:** During the epidemic, disparities in students' access to technology came to light. Institutions should make sure that students have access to the internet, computer hardware, and software they need to take online courses. Students with physical and cognitive limitations should also be able to access courses. Therefore, developing policies and plans to close the digital divide is crucial.

In general, more laws are required to enable online teaching and learning. The financing, personnel, technology, and existing policies that may be disparities in digital teaching and learning must also be reconsidered by instructional leaders.

➤ **Instructor Development.** When the pandemic started, faculty who were new to online teaching had to adapt quickly. Many needed to participate in digital teaching and learning professional development activities. As Dx marches forward, training opportunities and resources for faculty development need to evolve based on faculty needs. These resources are aimed at improving faculty members' pedagogical and technological skills and their knowledge about accessibility, intellectual property, and online teaching best practices.

➤ **Technological and pedagogical abilities:** Faculty should be provided the chance to advance their technological, pedagogical, and content-integration abilities. Professionals in faculty development should keep providing a variety of training on digital teaching and learning.

➤ **Views of the faculty:** From resistance to readiness, faculty views toward digital teaching and learning are changing. By emphasizing educating teachers how to create positive value views toward technology and digital teaching and how to integrate their teaching philosophies with digital teaching methods, professional development opportunities can assist this progression.

➤ **Accessibility:** Students with physical and cognitive limitations can benefit from accessible classes. The teaching staff must be ready to make their online courses accessible. This involves extra time and effort, administrative &technical assistance.

➤ **Copyright and intellectual property rights**: In order for professors to better understand intellectual property rights and the copyright of electronic products, they need resources and support.

During the pandemic, many faculty members did not have the time to put online teaching concepts into practice when they shifted to digital teaching and learning. Online courses can be made to be of higher quality by taking the time to reconsider and implement pedagogical best practices.

➤ **Student Development:** Students have the opportunity to learn in a variety of modalities thanks to digital learning. This equips them for the workforce of the future, where the majority of occupations will demand digital knowledge and abilities.

➤ **Access to computers and the internet:** For students to succeed as digital learners, they should have access to computers and the internet. Even while many students have access to these resources, there is still a digital gap. Before using digital teaching, professors and administrators must take into account students' access to digital devices.

- **Self-control and time management:** Digital education offers flexibility. However, this flexibility places a higher emphasis on self-regulated learning. For instance, during digital learning, students must learn to effectively manage their time, minimize distractions, and prevent procrastination.
- **Individuals and educational materials:** When instructors publish lectures, podcasts, and discussions, students must be able to learn from a range of content types (text, audio, and video). Additionally, they must learn how to interact in a digital setting with their teacher, peers, and content.
- **Help:** Students may be separated by distance in a digital learning environment, thus they must be able to contact one another for assistance. A technical help desk or a teacher could offer assistance.
- **Developing a community:** Students require chances to build social networks and venues for social engagement (such as online orientations, social time for students to mingle, etc.). For continued connection and involvement in digital learning, students will depend on their community.

Digital learners can succeed with the use of technology resources, time management techniques, self-control techniques, engagement techniques, and community building techniques.

Partnerships: The epidemic brought to light the opportunity to use numerous partnerships to provide high-quality digital teaching and learning.

- **Partnering with other academic institutions:** To assist instructors at other institutions, colleges and universities that already offered digital learning gave workshops and training. Globalizing these kinds of relationships might improve digital teaching and learning all over the world.
- **Cooperation with specialized organizations:** Higher education institutions were assisted by professional groups that are pioneers in digital learning by providing training, workshops, and resources.
- **Cooperation with industry:** In several nations, businesses outside of higher education have collaborated with colleges to offer access to the internet and electronic gadgets. Industry collaborations hasten the adoption of digital advances in higher education.

By leveraging the expertise of subject-matter experts, partnerships with colleges and universities, professional associations, and external companies boost digital teaching and learning activities.

Tools for Online Instruction and Learning

Virtual classrooms, solo exercises, real-time assessments, and collaborative group work are the four fundamental components of online instruction. Both student-student and faculty-student cooperation are facilitated by the usage of online instructional resources. The motivation of the instructor to use online teaching tools depends heavily on the simplicity, level of satisfaction, usefulness, and confidence of the instructor. Higher education institutions are conscious of the need to accommodate a wide range of learners, and Hilliard notes that in the era of blended learning, technical assistance and student and faculty understanding are crucial. The LMS and data analytics tool must work together to improve the course design and teaching effectiveness making use of online resources effectively.

Teaching Resources Online

It might be difficult for decision-makers to select the tools that best meet the goals of the course because there are so many online teaching resources available. Which tools are used by different learners and institutions depends on factors such as the necessity for the tools, their cost, usability, and functionality. Online courses are becoming widely available at universities. Students that choose part-time classes enroll in these. They now have more scheduling freedom, and going to campus is no longer necessary. Many, if not all, institutions were obliged to move all of their classes online in 2019 due to the pandemic crisis. The cost of LMS tools is typically broken down into four categories: (i) per learner, per month (ii) per learner, per year, and (iii) per learner.

Online Education Resources

A classroom management application frequently includes online teaching and learning as a component of the current semester. During the COVID-19 pandemic, schools and colleges widely embraced Microsoft Teams and GSuite for education to successfully move regular classes online. Edmodo, Blackboard, and Moodle Cloud are some further well-liked LMSs that have been used in blended learning. The benefits and challenges of online teaching are

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outlined in Table 1 by Davis et al. for both students and educators. Utilizing the right tools while creating a course is essential to its effectiveness. This entails getting students involved and adapting the course structure to accommodate different learning styles.

Innovative Teaching and Learning Practices: A Survey

The questionnaire attempts to gauge the efficiency of various online tools and technologies, students' preferred learning styles, and other elements that could affect the teaching-learning process. The parameters were based on the various learner kinds, benefits, and drawbacks of online education. To determine the student's preferred learning method, answer questions 1-4. To ascertain how well the teaching and evaluation medium is working, questions 5-7 are presented. To determine the many difficulties students, have with online learning, questions 8 through 12 are posed. Since the majority of students take online classes from home, this style was chosen since it will be acceptable to students from many universities. The poll was filled out by students.

CONCLUSION

Even though our methodology emphasizes seven key elements, obtaining Dx for digital learning is an ongoing endeavour. Dx efforts will be widespread for institutions of higher learning as cutting-edge digital technology improve. Dx for Digital Learning gives students access to freedom and mobility while preparing them to handle problems in the digital world. Higher education's norms and practices will continue to be shaped by Dx initiatives so that it can adapt to and change along with society.

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Table: 1 Benefits and Challenges of Online Teaching		
	Students	**Instructors**
Benefits	Flexibility	Improved Communication
	Self-motivation	Course Management
	Working independently	Course design
Challenges	Interpersonal relationships	Setting expectations
	Misinterpreting expectations	Providing feedback
	Time Management	
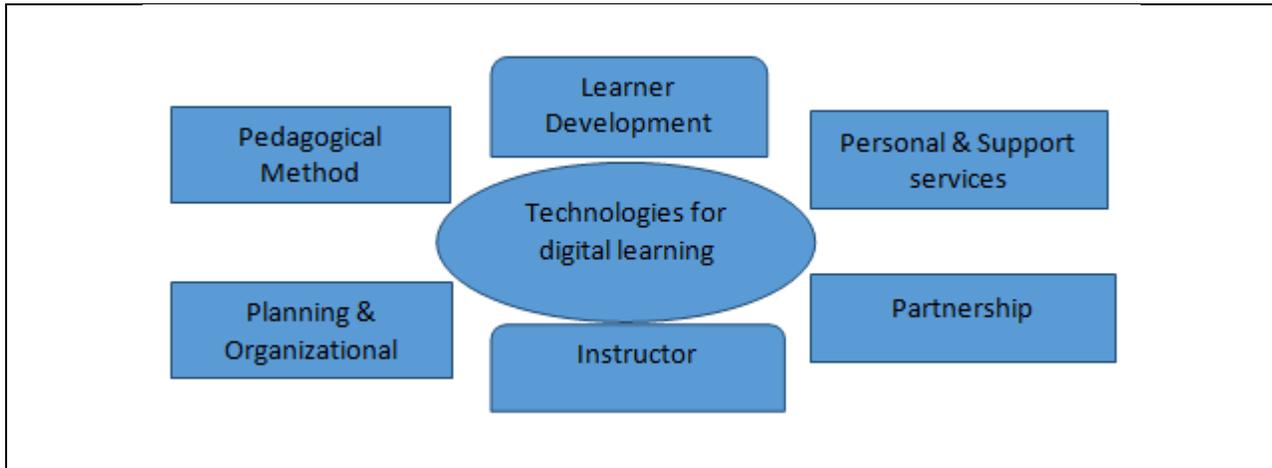
Figure 1. Digital Transformation for Educational Technology
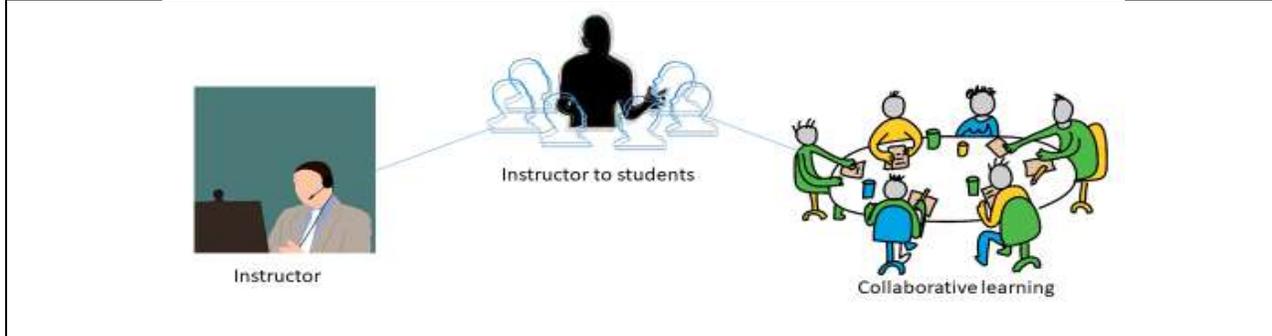
Fig. 2 The various components of effective usage of online tool

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Which of the following statements is true of online learning off Campus
102 responses

- No one disturbs online learning
- Friends/family members/roommates/ Neighbour occasionally disturb
- Friend/family members/roommates/ Neighbour constantly disturb

33.3%
15.7%
51%

At home/place of residence, how many responsibilities do you have?
102 responses

- I don't have many responsibilities
- I have a moderate amount of responsibilities, but i have sufficient time for online learning.
- I have many responsibilities, I don't have any time left for online learning.

66.7%
12.7%
20.6%

What is your most preferable methods for clearing doubts in online learning
102 responses

- Ask the professor during/after an online lecture
- Post the query in a discussion forum of your class & get help from your peers.
- Go through online material providing an additional explanation

29.4%
22.5%
48%

Which of the following devices do you use for your online learning
102 responses

Device	Value
A Laptop/desktop computer	54 (52.9%)
A tablet	11 (10.8%)
A Smartphone	58 (56.9%)
Other devices	3 (2.9%)

REVIEW ARTICLE

The Evolution of Neobanks: Transforming Banking for the Digital Age and Addressing Diverse Customer Needs

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ABSTRACT

In order to adapt banking to the digital age and meet the needs of a wide range of customers, the neobanking business has developed swiftly. Neobanks are online-only banks that place a premium on providing customers with a pleasant digital banking experience. They use cutting-edge innovation, provide novel banking services, and partner with more conventional financial institutions and fintech firms to better serve their customers. Customer uptake, trust and security concerns, regulatory compliance, monetization, and scalability are some difficulties that neobanks must overcome. Neobanks face these obstacles head-on by increasing public understanding, fostering customer confidence, negotiating increasingly complicated regulatory environments, creating long-term revenue streams, and guaranteeing streamlined operations. This research aims to examine the effects of the neobanking industry on conventional financial institutions and better understand its landscape, client perceptions, difficulties, and prospects. Policymakers and neobanks alike will receive advice on increasing profits, delighting customers, and pioneering change in the financial services sector.

Keywords: Customer-centric, Digital Banking, Neobank, Regulatory Compliance, Virtual Bank.

INTRODUCTION

A neobank is a virtual bank that does all of its business via a website or mobile app rather than through traditional brick-and-mortar locations. With the help of advanced technology, neobanks offer convenient and straightforward online banking services to customers. Some of Neobanks' defining qualities and traits are as follows:

- **Digital-first Approach:** Neobanks are based on digital infrastructures; customers engage with them mainly through mobile apps and websites. They put the customer first by providing easy-to-use interfaces and efficient procedures for all banking-related tasks.
- **Convenience and Accessibility:** Customers of neobanks can check their accounts, make transfers, and view statements whenever they like, day or night. They cater to the needs of tech-savvy consumers by emphasizing ease of use and customization.
- **Technology-driven Innovation:** To better serve their customers, neobanks employ cutting-edge technology like AI, ML, and data analytics. They employ these innovations to provide tailored monetary guidance, streamline operations, and bolster safety precautions.
- **Seamless Onboarding:** Most neobanks provide a straightforward and fast online signup procedure. No physical documents or in-person visits to a branch are required for customers to open accounts, verify identities, or access banking services.
- **Innovative Financial Products:** Typically, neobanks offer a wider variety of financial services and products than traditional banks. Features like automatic savings, investment opportunities, budgeting aids, cost monitoring, and real-time alerts on account activity are all examples.Several neobanks team up with other financial institutions to expand their product lines.
- **Competitive Pricing:** Neobanks frequently have lower or similar fee structures than conventional banks. They plan on saving money on infrastructure costs to offer reduced prices or even free services for some transactions.
- **Collaborations and Integrations:** To expand their services, neobanks may collaborate with conventional banks, fintech firms, or other financial institutions. By pooling resources, neobanks can expand their service offerings to include loans, insurance, and investment opportunities.

Although neobanks are digital, they are subject to banking rules and must follow security and privacy requirements to protect their customers' information and financial transactions.

Generally speaking, neobanks want to change the face of banking by providing customer-focused, tech-driven, and easily accessible financial services that meet the needs of today's tech-savvy consumers and enterprises.

STATEMENT OF THE PROBLEM

There has been a lot of development and change in the neobanking sector in recent years, but specific problems also need fixing. These problems are uncovered:

- **Customer Adoption and Awareness:** Even while neobanks are becoming increasingly common, there is still a pressing need to educate the public and inspire widespread adoption. Customers may hesitate to switch from their current bank because they lack knowledge about neobanking offerings. The challenge is reaching out to potential consumers and convincing them of the value of neobanks.
- **Trust and Security Concerns:** Customers place a high premium on safety and reliability in financial services. For clients to feel safe depositing money and providing personal information to neobanks, the institutions must show that they have taken extensive security precautions. Neobanks can only continue expanding if customers have faith in them and their safety is a top priority.
- **Regulatory Challenges:** The regulatory environment in which neobanks must function is intricate. Data privacy, AML, and KYC standards provide particular difficulties for neobanks regarding ensuring regulatory compliance. Finding a middle ground between creative risk-taking and strict adherence to rules is a significant challenge for neobanks.
- **Monetization and Profitability:** The neobanks' difficulty isprofit-making while providing affordable services with added value. Financial sustainability is an issue for many neobanks because they put so much effort into

expanding their customer base and entering new markets. The long-term survival of neobanks depends on their capacity to create reliable revenue streams and turn a profit.

- **Scalability and Operational Efficiency:** As neobanks expand rapidly and attract a more extensive user base, scalability becomes increasingly important. It might be difficult for neobanks to ensure that their systems, processes, and infrastructure can keep up with rising transaction volumes without compromising service quality.

Statistics related to the statement of the problem:

- Accenture predicts that by 2023, the number of neobank users worldwide will have risen to 394 million, a sizeable market (Accenture, 2021).
- PwC discovered that 61% of customers worry about the safety of their data when dealing with neobanks, demonstrating the need to resolve issues of trust and security (PwC, 2019).
- According to PwC's Global Fintech Report 2019, 71% of consumers still favor traditional banks over neobanks. This disparity highlights the importance of educating and winning over more customers (PwC, 2019).
- According to a report conducted by Statista, 32% of neobank executives cite regulatory compliance as a significant worry for their industry (Statista, 2020).
- A similar Statista analysis indicated that nearly half of the neobank CEOs saw profitability and monetization as significant obstacles in the neobanking space (Statista, 2020).

The future of neobanks and the benefits they can provide customers and the banking sector depend on these issues being resolved.

OBJECTIVES OF THE STUDY

This research aims to accomplish the following:

i. **Assess the current landscape and trends of neobanking:** The primary objective of this research is to offer a comprehensive evaluation of the neobanking sector worldwide. The report will analyze the growth of neobanks and highlight the market leaders.

ii. **Understand customer perceptions and preferences:** The research investigates how customers view neobanks and what features they value most. It will examine what makes clients interested in, comfortable with, and willing to switch from traditional banks to neobanks.

iii. **Identify the challenges and opportunities for neobanks:** Regulatory constraints, security threats, and scalability problems are just a few of the obstacles that will be investigated in this research on neobanks. It will also look into the possibilities for neobanks, such as new business areas, partnerships, and creative banking services.

iv. **Analyze the impact of neobanks on the traditional banking sector:** This research was initiated to determine how neobanks compare to more conventional financial organizations. It will analyze the current state of the market and how neobanks have altered the banking industry. Traditional banks' reactions to the emergence of neobanks and their tactics for adjusting to the new banking environment will also be examined.

v. **Provide recommendations for neobanks and policymakers:** The study's findings will inform actionable recommendations for how neobanks may better serve their customers, streamline their processes, and face and overcome obstacles. Furthermore, it will provide regulators and policymakers with insights and policy recommendations to help them foster an environment where neobanks can flourish while protecting consumers and maintaining financial stability.

SIGNIFICANCE OF THE STUDY

The findings of this research have significant ramifications for the banking industry and its clients. The following are examples of the study's significance:

- **Industry Insights:** The analysis sheds light on the neobanking industry's growth rate, prospects, and possibilities for disruption. It thoroughly analyzes the problems, possibilities, and future of neobanks so that interested parties can make well-informed choices.

- **Customer Perspective:** The study provides valuable insights into customer behavior and expectations in digital banking by analyzing customer perceptions, preferences, and adoption patterns. The success of neobanks depends on their ability to provide excellent service and make their customers happy.
- **Regulatory Implications:** The research delves into the difficulties of complying with regulations and the pressures placed on neobanks. It elucidates the changing regulatory landscape and offers suggestions to policymakers to foster innovation in a secure and safe environment for consumers and businesses alike.
- **Competitive Analysis:** The paper analyses how neobanks have altered the competitive landscape of the banking industry by comparing them to more conventional financial organizations. Traditional banking institutions can benefit from this information because it aids in their analysis of the market and the development of competitive strategies.
- **Business Opportunities:** Business opportunities for neobanks and fintech startups are highlighted in the study by identifying market niches, collaboration opportunities, and product diversification channels. It is a helpful tool for business owners, financiers, and other stakeholders interested in the expanding neobanking sector.

THE EVOLUTION OF NEOBANKS IN INDIA

In recent years, neobanks—also known as online banks or mobile banking platforms—have made significant progress in India. Traditional banking methods are being challenged by fintech businesses using technology and mobile apps to provide digital banking services.

- **Emergence and Growth:** In 2015 and 2016, with the advent of digital banking and fintech businesses, neobanks in India began to gain popularity. Since then, neobanking has expanded dramatically thanks to rising demand for digital banking and the government's efforts to broaden access to banking services.
- **Customer Base and Market Penetration:** The young and technologically skilled have been the primary focus of India's neobanks. The number of people using neobanks in India is expected to grow by 270 percent between 2018 and 2020, according to a study by Razorpay. Increased interest in digital banking services among Indian consumers is seen in this trend.
- **Funding and Investments:** Venture capital firms and other investors have poured much money into India's neobanking sector. NiYO Solutions, an Indian neobank, raised about $49 million across multiple fundraising rounds by 2020. Such funding shows investors' faith in the expansion prospects of India's neobanks.
- **User-friendly Interfaces and Innovative Features:** Innovative and straightforward, neobanks cater to a wide range of customers. They offer user-friendly banking apps that can be used from a mobile device anytime. Many of these applications also include automated savings and investing options and tailored financial advice based on your spending habits and goals.
- **Partnerships with Traditional Banks and Fintech Companies:** In India, numerous neobanks have partnered with established financial institutions and innovative fintech firms. As a result of these collaborations, neobanks can offer cutting-edge digital banking solutions by piggybacking on the infrastructure and permissions of more established financial institutions. They also work with fintech firms to broaden their product lines by incorporating payment processing, insurance, and investment management services.
- **Regulatory Landscape:** The Reserve Bank of India (RBI) has proactively helped neobanks expand while maintaining safety and soundness. By 2018, thanks to the "Account Aggregator" structure, neobanks will have safe access to customer data from various traditional and alternative financial institutions. This structure helps neobanks improve their client service and open the door to comprehensive banking options.

SIGNIFICANT GROWTH AND SUCCESS OF NEOBANKS

Neobanks have seen massive expansion and success because they focus on the demands of their end customers.

- **Convenience and Accessibility:** Neobanks puts a premium on client care and ease of use; therefore, they design their digital platforms and mobile apps with portability in mind. This delivers a more convenient and up-to-date banking experience for today's consumers by doing away with the need to visit a physical branch.
- **User-Friendly Interfaces:** Neobanks spend much money making their user interfaces simple. They know how important providing a pleasant banking experience is, so they have made navigating and customizing their

dashboards and other features easy. Neobanks streamline the banking process and improve customer satisfaction by putting the user first.

- **Speed and Efficiency:** Neobanks use cutting-edge technology to improve efficiency across the board, allowing them to serve customers quickly and effectively. Customers can open accounts, transact business, and get at their money fast without dealing with the red tape and lengthy procedures typical of conventional banks. In order to keep up with their customers' hectic schedules, neobanks prioritize making transactions as simple and quick as possible.
- **Personalized Financial Solutions:** Neobanks go above and beyond traditional banking by providing customers with individualized financial solutions.Using data analytics and machine learning algorithms, Neobanks can deliver valuable insights and recommendations by analyzing customers' behavior, spending habits, and financial goals. Customers benefit from this customized approach since it allows them to make well-informed financial decisions.
- **Cost-Effectiveness:** Neobanks frequently use a lean business model, cutting expenses wherever possible by relying on digital infrastructure. This paves the way for low- or no-cost banking services, bringing the cost of personal finance management down to a level within reach of more people. Neobanks appeal to frugal customers who value convenience and honesty in their banking by offering services at lower rates or without hidden fees.
- **Innovative Features and Services:** The ever-changing needs of their customers need the constant development and rollout of new features by neobanks. Budgeting aids, spending grouping, saved-money auto-deposits, invested-money choices, and instant alerts on account activity are among the things they may provide. Neobanks provide customers with more agency over their financial lives and help them reach their financial goals by offering these cutting-edge services.

As a whole, neobanks find success by catering to the most fundamental demands of their customer base in terms of accessibility, use, speed, personalization, efficiency, cost, and novelty.Neobanks have found success by filling this void in the banking sector, attracting customers who value convenience and technological sophistication in their financial service providers.

OPERATIONAL ARCHITECTURE OF NEOBANKS

"Operational architecture" refers to the framework and procedures that make neobanks or digital banks possible. The essential parts of a neobank's operating architecture are as follows.

- **Core Banking System:** Neobanks' day-to-day operations would collapse without their respective fundamental banking platforms. These systems manage customer information, financial transactions, and account balances. They guarantee that the neobank's activities run smoothly and allow for easy connection with other architectural parts.
- **Digital Platforms:** Neobanks rely heavily on digital channels for interacting with their customers, such as mobile apps and web interfaces. Thanks to these systems, customers can manage their accounts, make transactions, and get their financial data whenever and wherever they choose.
- **API Integrations:** Application programming interfaces are frequently used by neobanks to connect with third-party service providers (APIs).Usingits partners' strengths, neobanks can expand its product offerings to include payments, investments, and insurance. APIs allow data to be freely shared and systems to work together without hiccups.
- **Cloud Infrastructure:** The cloud is used by several neobanks as a backend system for their operations. With cloud computing, neobanks can process massive volumes of transactions, keep customer information safe, and roll out innovative new services with minimal upfront investment.
- **Security and Compliance:** Safety and adherence to rules are prioritized in neobanks. They use advanced security tools, including encryption, multi-factor authentication, and fraud detection systems, to keep customers' information and financial dealings safe. Additionally, neobanks guarantee adherence to laws concerning consumer privacy, AML, and KYC practices.

- **Data Analytics and AI:**   Neobanks use data analytics and AI to understand customers' spending habits better, saving goals, and other financial details. In order to tailor their services, make more accurate risk assessments, and provide superior service, they sift through mountains of consumer data. Artificial intelligence paves the way for automated tasks, conversational bots, and analytical forecasting.
- **Customer Support:**   For neobanks, customer service, and interaction are top priorities. They offer a variety of ways for customers to get in touch with help, such as chatbots within the app, email, and phone. Neobanks prioritize providing timely and individualized assistance to customers to answer their questions, solve their problems, and develop lasting connections with them.

EVOLUTION OF THE GLOBAL NEOBANKING LANDSCAPE

Technology and shifting consumer tastes have rapidly transformed the worldwide neobanking scene in recent years. Here is a historical perspective on the development of neobanking around the world:

- **Early Pioneers:**   Companies like Simple (bought by BBVA in 2014) and Moven were at the forefront of the neobanking revolution when it first began in the middle of the 2000s. These forerunners popularised the idea of banking solely online, with an emphasis on creating superior experiences for their customers.
- **Market Expansion:**   The 2010s saw the worldwide proliferation of neobanking thanks to the success of digital-only financial institutions like N26, Revolut, and Monzo. These neobanks sprang to prominence due to the convenience of their websites,the speed with which they processed international transactions, and the low rates they charged for currency exchange. They changed how people bank by providing new levels of openness, comfort, and value.
- **Product Diversification:**   The services offered by neobanks have expanded beyond traditional banking necessities. Now, integrated financial marketplaces offer features like budgeting tools, spending tracking, investment opportunities, insurance offerings, and more. By forming strategic alliances with fintech firms, neobanks can diversify their offerings and meet the needs of a broader spectrum of customers.
- **Regulatory Considerations:**   As the number of neobanks has increased, so have the regulations governing them. In order to encourage the development of novel banking strategies, regulators have introduced specializedlicenses or "sandboxes." For instance, the European Union's Revised Payment Services Directive (PSD2) enabled neobanks to access banking data via open banking APIs to increase competition and customer choice.
- **Collaboration with Incumbents:**   There has been a rise in neobank partnerships with more conventional financial institutions. Neobanks can use preexisting resources through these partnerships, including infrastructure, regulatory authorizations, and customer bases. By partnering with neobanks, both traditional and new financial institutions can take advantage of the advantages offered by each.
- **Global Expansion and Consolidation:**   Many neobanks now operate in more than one country, catering to customers worldwide. Consolidation has also occurred inside the neobanking sector, with mergers and acquisitions occurring to fortify market positions and speed up expansion.

CUSTOMER SEGMENTS IN NEOBANKS

Different types of neobank customers can be distinguished by their demographics, financial situations, and personal preferences. Common types of customers who frequent neobanks include:

- **Millennials and Tech-Savvy Users:** Customers conversant with digital technology and desire streamlined mobile banking experiences are a standard draw for neobanks. Because of their comfort with modern technology and preference for flexible, individualized banking options, millennials have embraced neobanking services quickly.
- **Freelancers and Gig Economy Workers:** Freelancers, contractors, and others who participate in the "gig economy" are the primary customers of neobanks. Neobanks provide convenient services for these consumers, including invoicing, expense tracking, and tax administration.

- **International Travelers and Expats:** Individuals who frequently travel overseas or live abroad can benefit from the ease and low cost of using a neobank. Their multi-currency accounts, fast transfers, and low foreign exchange rates are selling points.
- **Underbanked and Financially Underserved Individuals:**   Many people cannot access conventional banking institutions easily; neobanks are an excellent option. Neobanks make banking services more available to the unbanked by providing essential banking functions with streamlined on boarding processes and no minimum balance requirements.
- **Small and Medium-sized Enterprises (SMEs):**   Neobanks offer specialized banking services to small and medium-sized businesses. Simplified loan applications, consolidated billing, and invoice tracking are some examples of the services that may fall under this category.

IMPACT OF NEOBANKS ON THE TRADITIONAL BANKING SECTOR

Understanding the revolutionary nature of digital banking requires examining how neobanks have altered the landscape of traditional banking. The impact of neobanks on conventional financial institutions is examined below.

- **Competition and Market Disruption:**   The advent of neobanks has injected new competition into the banking industry, posing a threat to legacy financial institutions with their cutting-edge digital services. To compete with these new digital upstarts, incumbent banks have had to rethink their customer service models, user interfaces, and operational agility.
- **Technological Advancements:**   To provide customers with better financial services, neobanks have been on the cutting edge of using technology. Innovative neobanks have raised the bar for customer experience regarding responsiveness, ease of use, and customization using cutting-edge technology like AI, ML, and data analytics. For customers' sake, even the oldest banking institutions had to catch up and use similar tools.
- **Customer Expectations and Experience:**   Customer service at neobanks is much more advanced than traditional banks. Their simple user interfaces, quick transaction updates, and adaptable money management features have altered consumers' expectations. To compete with neobanks and satisfy new consumer expectations, traditional banks have been forced to invest in digital transformation and revamp their customer experiences.
- **Innovation and Product Development:**   Neobanks were the first to introduce ground-breaking financial services. By providing services such as quick payments, automatic savings, budgeting tools, and integrated financial marketplaces, they have challenged the status quo of conventional banking. In response, traditional financial institutions have begun offering comparable services in-house or forming strategic alliances with newer fintech companies.
- **Collaboration and Partnerships:** Since the advent of neobanks, conventional banks, and fintech firms have begun working together. There is a growing trend of traditional financial institutions working with or acquiring neobanks to improve digital services. By working together, traditional banks may take advantage of neobanks' speed and creativity while keeping their customers and systems in place.
- **Regulatory Response and Open Banking:** Competition, innovation, and client choice are all bolstered by new frameworks like open banking that regulators have introduced in response to the rise of neobanks. To better serve their customers, traditional banks have been urged by open banking initiatives to expose their application programming interfaces, paving the way for partnerships with neobanks and fintech companies.

RECOMMENDATIONS FOR NEOBANKS

- **Enhance Security and Trust:** To gain customers' trust, neobanks must stress stringent security and privacy protections. Modern encryption tools, multi-factor authentication, and preventative fraud detection systems can allay security concerns.
- **Emphasize Financial Education:** Customers' financial literacy and familiarity with neobanking services benefit from the neobanks' investment in education programs. Customers may make better decisions and take full advantage of neobanks' features and benefits if they have access to educational tools, tutorials, and individualized suggestions for financial management.

- **Foster Collaboration:** Neobanks should consider forming partnerships and cooperation with conventional banks, fintech companies, and other financial institutions. By pooling resources, neobanks can increase their competitive advantage, reach more customers, and diversify their offers.
- **Focus on Personalization:** Neobanks need to keep perfecting customer-specific financial products. Using data analytics and machine learning algorithms, neobanks can provide individualized suggestions, budgeting tools, and financial guidance.
- **Improve Scalability and Operational Efficiency:** Neobanks, as they expand, need to focus on scalability and efficiency. In order to keep up with rising transaction volumes without sacrificing service quality, neobanks must invest in scalable infrastructure,optimize processes, and leverage automation technology.

RECOMMENDATIONS FOR POLICYMAKERS
- **Foster Innovation-Friendly Regulatory Frameworks:** Policymakers should foster an innovative regulatory climate that fosters the development of neobanks. Regulations should be risk-based, flexible, and technology-agnostic to promote innovation while protecting consumers and the financial system.
- **Promote Open Banking and Data Sharing:** Open banking projects that allow for the safe and regulated exchange of customer information between neobanks, traditional banks, and approved third-party providers should be supported by policymakers. In the financial services industry, open banking has the potential to increase competition, foster innovation, and broaden consumer options.
- **Streamline Regulatory Compliance:** Government officials should prioritize making it easier for neobanks to comply with regulations. One way to accomplish this is by creating regulatory sandboxes where new ideas can be tried without fear of repercussions.
- **Encourage Financial Inclusion:** Neobanks' attempts to reach unbanked people are commendable, and policymakers should encourage them. Expanding access to financial services for all members of society can be accomplished through initiatives like fostering digital infrastructure access, establishing partnerships with local communities, and offering incentives for servicing underbanked individuals.
- **Collaborate with International Regulators:** Policymakers and international regulators should work together to create a unified set of rules and regulations for neobanks.By working together, the global digital banking ecosystem can function more smoothly, assure regulatory uniformity, and safeguard its customers.

CONCLUSION

As a result of their customer-focused, tech-driven, and convenient digital banking services, neobanks have emerged as a major industry disruptor. They have pushed conventional banks to innovate in response to customers' shifting needs and expectations by introducing new services and improving existing ones. However, neobanks still have obstacles that must be overcome to experience long-term growth and success. Adoption and awareness from customers, trust and security worries, regulatory compliance, monetization and profitability, scalability, and operational efficiency are all obstacles that must be overcome. If neobanks want to prove themselves as competitive alternatives to more established financial institutions, they must find ways to overcome these obstacles.

Significant disruption to the conventional banking system has resulted from the rise of neobanks. Established banks have been forced to invest in digital transformation, adopt cutting-edge technologies, and enhance their customer experiences in response to the threat posed by neobanks. Traditional banks and neobanks are increasingly working together and forming partnerships,introducing new, cutting-edge features and services. Market growth, product variety, regulatory shifts, and new partnerships are all examples of how the neobanking industry has changed and adapted. Customers from all walks of life, including millennials, freelancers, international travelers, and the underbanked, have flocked to neobanks because of their services. By putting the customer first,utilizing cutting-edge technology, and providing customized banking services, neobanks have revolutionized the banking industry. As the neobanking business develops, neobanks will have to meet new hurdles, establish credibility, forge partnerships,

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and comply with new regulations. Neobanks can establish themselves as viable competitors by pushing the envelope this way.

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RESEARCH ARTICLE

Impact of Demographic and Work Related Profile of IT Employees on their Emotional Intelligence – A Study across Select IT Companies in Bangalore City

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ABSTRACT

Individual productivity and performance are becoming more commonly recognised as a predictor of emotional intelligence (EI). Despite criticism of measurement methods, many authors agree that EI has an impact on individual performance. Because companies are always looking for ways to enhance their HRM, the topic of EI remains pertinent. Maintaining high levels of emotional intelligence (EI) is especially important in this setting since it is linked to the capacity to adapt to different individuals and circumstances. But there are a lot of things that may affect how EI is measured. Biological, psychological, and social factors all have a role in EI levels. Some researchers think that EI can be enhanced, most likely through education and awareness programmes. In light of this, the current study looked at demographic (age, gender, educational attainment, marital status, and yearly income) and work-related factors (job positions, experience, work shift, work hours, overtime, and flexitime) characteristics as predictors of EI levels. The study is descriptive in nature and 129 IT Employees have been a part of the study based on the Cochran formula of known population-95% confidence and 10% margin of error. A well-structured questionnaire was used which was adapted from Goleman EI Scale of 2012. The hypothesis was tested using Independent sample T-test and analysis of variance. Employees above the age of 45 years had better emotional intelligence, according to a survey of demographic characteristics. For marital status and monthly income, emotional intelligence elements are negligible. In comparison to males, women have a higher level of self-awareness. The majority of the factors in the Work profile were negligible. Differences

in EI levels among IT personnel were identified based on several demographic and work-related variables. Demographic and occupational factors may significantly affect EI, even though most of these variables were not statistically significant. More research is required to compare IT professionals to other knowledge professions, according to the results.

Keywords: Emotional Intelligence, work Profile, Demographic profile, IT employees

INTRODUCTION

More and more people are beginning to see emotional intelligence (EI) as a measure of how well people function and how productive they are (Bande *et al.*, 2015). Many writers concur that EI affects performance, despite criticism of assessment methods (Murphy, 2014). A key component of psychological capital, self-efficacy, shows a positive association with EI(Pradhan, Jena, and Sing, 2017). Companies are still tryingto find methods to make their HR department work consistently, therefore EI is still a hot subject. Keeping one's EI levels high is especially important in this regard because of the significant correlation between EI and the ability to handle variety and change (Kaufmann & Wagner, 2017). Workers may experience mental and emotional distress due to the unique challenges of each profession (Oatley & Johnson-Laird, 2014). But this research suggests that IT workers may be experiencing more emotional strife than other departments. In addition, the IT sector is now more competitive due to higher human capital mobility across continental and national boundaries. According to Andrés, Asongu, and Amavilah (2015), research has grown in importance within the academic sector and the global economy has shifted towards being more knowledge-driven.

Higher education enrolment has been on the rise over the last 20 years (Coates *et al.*, 2015). Having strong interpersonal skills is also essential for success in the IT business. Neglecting to deal with any of these elements in a healthy way may lead to negative feelings, which in turn can reduce one's efficiency and effectiveness. Because of this, EI is used to enhance the efficacy of communication (Jorfi, Yaccob, & Shah, 2011), organizational and work psychology (Jorfi *et al.*, 2016), and personal psychological health (Bande *et al.*, 2015). Consequently, since EI may affect performance in many domains, an individual's level of EI becomes important. But there are a number of factors that might affect EI. (Pooja and Kumar, 2016) states that there are social, psychological, and biological factors that contribute to EI levels. Ebrahimi, Khoshsima, & Zare Behtash (2018) state that there are academics who believe EI may be enhanced via awareness seminars and development programs. This study examined the connection between EI and demographic and occupational factors such as age, gender, education, marital status, and income. It also examined work-related factors such as job duties, experience, shift, hours worked, overtime, and flexitime. The results were based on previous research by (Konya *et al.*, 2016).

REVIEW OF LITERATURE

Age is a factor in both EI and unproductive conduct in the job, according to Samanta and S. Kallou (2020). Employees at Chalkida Municipality were determined to have a high level of emotional intelligence and would not intentionally harm the company's production, according to their research. The correlation between EI and demographic variables among Malaysian polytechnic instructors was investigated in a study by Kumar *et al*. (2012). Time spent teaching, seniority, degree of education, and job title were all factors that raised EI, according to the study's authors. The gender gap, years of experience in the workforce, and EI need did not correlate. Goleman claims that EI is the same for men and women (1998). The results of previous research have consistently shown that, in both personal and professional contexts, women exhibit higher levels of EI than males. According to Cruz (2004), women excel in both the home and the workplace when it comes to handling emotions. There is a gender disparity in involvement in many activities, and researchers have shown that this difference is related to human values and society ideals of masculinity and femininity. To determine whether self-esteem varies by gender, Petrides, Furnham, and

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Frederickson (2004) surveyed 261 individuals in England using a correlational sample. When looking at EI as measured by self-esteem, the results showed that gender had a significant role.

Austin, Erans, Goldwater, and Potter (2005) found that women are naturally more empathetic and attentive, whereas men are naturally better able to control their emotions. Bar-On(2000) looked on the correlation between gender, age, and race. Aspects of EI differed between the genders, while the results showed no statistically significant variations between the genders with regard to overall emotional and social capacities. Researchers found that compared to men, women are more emotionally intelligent, compassionate, and extroverted. It would suggest that males are more self-assured, capable of problem-solving, resilient to stress, and self-reliant, agile, and self-confident than women. More similarities than differences were identified when he compared the EI of men and women generally. Total EI is therefore not different between the genders. Findings on the gender-EI link from the literature review showed a broad variety of opinions. In the opinion of the researcher, further research on EI and gender is necessary. In a study conducted by Min (2010), the correlation between EI, age, marital status, and education level of tour guides was examined. The results showed that characteristics related to gender and service time varied among individuals' EI. While some research has shown a correlation between EQ and longevity in the workforce, other studies have failed to uncover any such association. Among the faculty members of Malaysian technical and vocational colleges, there were no significant variations in emotional intelligence according to gender or age (Mustafa *et al.*, 2014).

Gender, age, marital status, and job title are factors that impact emotional intelligence among Greek banking sector employees (Papathanasiou & Siati, 2014). Rahim and Malik (2010) looked at how demographics affect EQ and how productive an organization is. There was a negative correlation between the ages of male and female bank workers and emotional intelligence, and female bank employees were more emotionally intelligent than male bank employees. An individual's emotional intelligence supposedly increases in tandem with their degree of schooling. Researchers have shown that when workers are content, they give their all on the job. According to certain research, gender and age are factors that influence emotional intelligence development (Mo & Dainty, 2007; Mandell and Pherwani, 2003). Gender, level of education, and retention were shown to be demographic characteristics that impacted emotional intelligence scores in the research by Mishra and Mohapatra (2010). The results showed a favorable correlation between higher degrees of emotional maturity and better executive function. There was a favorable correlation between intellectual ability and work experience. The communication skills of executives with greater experience are somewhat higher than those of less experienced employees. When comparing male and female employees, Gani (2013) discovered no statistically significant variations in EQ. Emotional Recognition and Speech Factor are two areas where women outperform men, according to the study's authors. (Downey *et al.*, 2005) found that when comparing male and female managers with transformational leadership behaviors, the former tended to exhibit higher degrees of emotional maturity and intuition. Compared to the general test, an assessment of emotional intelligence (EI) in the workplace was shown to be a more accurate predictor of transformative leadership practices. The extent to which an individual has EI is affected by many circumstances. Personality traits, upbringing, and other environmental influences all play a part in determining EI. There are academics who believe that EI can be improved, most likely by awareness lectures and training. In light of the research conducted by Hemalatha (2014) and Kónya, Matic, and Pavlovic (2016), this study aimed to determine the relationship between EI levels and demographic and work-related variables. "Demographic variables" included age, gender, qualification, marital status, and annual income. "Work-related variables" included job roles, experience, work shift, hours worked, overtime, and flexitime.

Objectives
To analyse the impact of demographic and work related profile of IT Employees on their EI

Hypothesis
H1: The EI of information technology workers is significantly affected by demographic factors.
H2: Work-related factors have a substantial effect on the emotional intelligence of information technology workers.

Research Design

The study's descriptive and quantitative research approach was used since the variables being studied were of a continuous nature. The survey was conducted using trustworthy, well-structured questions. Out of 150 questionnaires, 129 were deemed valid for the research. Questionnaire consisting of 3 Parts. First Section: Respondent Demographic Profile Data. Two, details on the respondent's job profile. The research used a convenient sampling approach.

RESULTS AND DISCUSSION

Demographic Profile of the Respondents

A majority of 55% of the IT Employees are between 26-45 years, 27.9% respondents are between 36-45 years. A very percentage of respondents are in the range of 18-25 years and above 45 years.68.2 % respondents are male and remaining 31.8% are Female. As per the IT Gender diversity, IT industry has 26% women employees, which is the same with the respondents under the study. A majority 58% of respondents have completed their Post-graduation, 51% have completed their graduation. As the study is carried out across IT Industry, A preponderance respondents are highly qualified. About half 51.2 % respondents are married, 46.5% respondents are single. Half of the respondents under study earn between 2-6 lakhs, 39% earn above 10 lakhs.

Work Profile of the Respondents

When enquired about the Job levels, 46.5% respondents are in the Middle level, 22.5% respondents are in the Upper Middle level, 20.2% IT employees are in Entry Level. A very small percentage of employees are in Top level. 48.1% respondents have below 5 years of experience, 30.2% respondents have 5-10 years. A cumulative 21% respondent have above 10 years of experience. A majority of 49.6% respondents work 9-10 hours, 36.4 % IT Employees worked for 6-8 hours. A very small 14% respondent's work for more than 10 hours a day. 86.8% IT Employees worked in Day shift.44.2percentage respondents worked overtime once in a week and 15.5% IT Employees did not work overtime. 69.8% respondents had the option of flexitime.

Descriptive statistics – Emotional Intelligence

The descriptive statistics for 4 items under emotional intelligence are illustrated in the table above. Self-awareness has the least mean score of 3.77 indicating neutral to agreement range of responses. Relationship management has the highest mean score of 4.08 indicating agreement to strong agreement range of responses. The SD is below 1.0 signifying that all the IT Employees under the current study have similar range of responses. Kurtosis is a measure of the shape of the current curve in relation to the normal distribution, while skewness is a measure of how the answers are distributed. The tolerable kurtosis range is -3 to +3, while the skewness range is -1 to +1. (Hair and *et al*, 2007). More responses are placed to the right when the skewness is negative. Positive skewness also shows answers that are skewed to the left. The skewness values for emotional intelligence items are negative, fall inside the acceptable limit, and are tailed to the right, suggesting that more respondents agree. All emotional intelligence components have Kurtosis within acceptable bounds, suggesting that they are close to the Normal Distribution.

Testing of Hypothesis

H1: The emotional intelligence of information technology workers is significantly affected by demographic factors.

At p value of.000, the emotional intelligence items are statistically significant for at least one of the age groups. According to the Scheffe post hoc data, employees over 45 exhibit higher levels of emotional intelligence. Consistent with other studies, this one found that emotional intelligence increases with age (Tsaousis & Kazi, 2013). In time, individuals may have a better grasp of their own and others' emotional states as a result of their upbringing and the lessons they've learned (Kaufman *et al.*, 2008).

At p value =.000, the self-awareness question is statistically significant for at least one of the qualification groups. The other items related to emotional intelligence are not important. Pooja *et al*. (2016) found that EI values varied by background and that non-technical service workers in India had higher EI scores than technical workers, which is

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consistent with the current study's findings. According to the current study, workers with professional degrees have higher levels of emotional intelligence. Regarding marital status and monthly income, emotional intelligence items do not make a difference. (Bibi & Farzana, 2015). Additionally, there were no statistically significant variations in EQ between married and unmarried college faculty members, according to this study. Only self-awareness is significantly related to gender, and women tend to be more self-aware than men. In line with previous research, this study confirmed that men and females scored differently on measures of emotional self-awareness, interpersonal connections, self-esteem, and empathy (Meshkat & Nejati, 2017).

- Job roles are insignificant in making any impact on the EI items as the significance values are above the expected p value of 0.05
- SM, Soc. A. and RM are statistically significant for atleast one of the Experience groups at p value =.000. The scheffe post hoc results show that employees who have above 10 years of experience have higher emotional intelligence
- SM, Soc. A. and RM are statistically significant for atleast one of the work hours groups at p value =.000. The scheffe post hoc results show that employees who work between 6-8 hours have higher emotional intelligence
- Work shifts are insignificant in making any impact on the emotional intelligence items as the significance values are above the expected p value of 0.05
- Overtime are insignificant in making any impact on the emotional intelligence items as the significance values are above the expected p value of 0.05

Suggestions

- Employees who are below 45 years need to access their emotional intelligence through questionnaires and try to adopt some of the techniques to improve Emotional intelligence. Organizations can take up activities and training programmes to enhance the EI of employees who are below 45 years
- IT Male employees can work on their self-awareness, Organizations can set up special programmes for men to enhance their self-awareness.
- Post graduates in technical field need to enhance their emotional skills to be equally competent with their non-technical counterparts. During the training sessions, importance has to be given to Technical employees so as to improve their emotional knowledge

CONCLUSION

The existing literature on EI and IT workers is expanded upon by this research. Human resource operators, career counsellors, and information technology workers who are looking to further their careers professionally may all benefit from the study's conclusions. Distinct variations in EI levels among IT workers were identified according to several occupational and demographic variables. There may be a real relationship between EI and demographic and occupational variables, even if most of them were not statistically significant. The results indicate that in order to compare IT staff with Other Knowledge workers, further study is required.

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Table 2- Descriptive statistics – Emotional Intelligence

Descriptive Statistics							
	N	μ	SD	Skewness		Kurtosis	
	Stat.	Stat.	Stat.	Stat.	SE	Stat.	SE
Self-awareness	129	3.77	.593	.115	.213	-.436	.423
Self-Management	129	3.78	.696	-.386	.213	.287	.423
Social Awareness	129	3.81	.830	-.622	.213	.902	.423
Relationship Mgt	129	4.08	.740	-1.039	.213	2.882	.423

Table 3 – Statistical test Results for Hypothesis 1

	ANOVA- F Statistics				Independent t test
Demographic Variables	Age	Qualification	Marital Status	Monthly Income	Gender
Self-awareness	3.334*	3.687*	0.565	0.659	6.196*
Self-Management	4.922*	1.835	0.151	3.034	4.547
Social Awareness	9.827*	1.217	0.276	2.413	4.029
Relationship Mgt	13.678*	1.392	0.037	2.289	1.361
* Indicates significance – Which is also shown in Chart 3					

Table 4- Statistical test Results for Hypothesis 2

Work related variables	Job roles	Experience	Hours of work	Work shift	Overtime
Self-awareness (SA)	1.275	2.632	2.412	1.612	1.398
Self-Management (SM)	0.997	3.538*	3.818*	1.613	1.038
Social Awareness (Soc. A)	2.358	7.226*	8.180*	0.913	1.591
Relationship Mgt (RM)	2.127	3.736*	3.724*	1.535	0.808
* Indicates significance – Which is also shown in Chart 4					
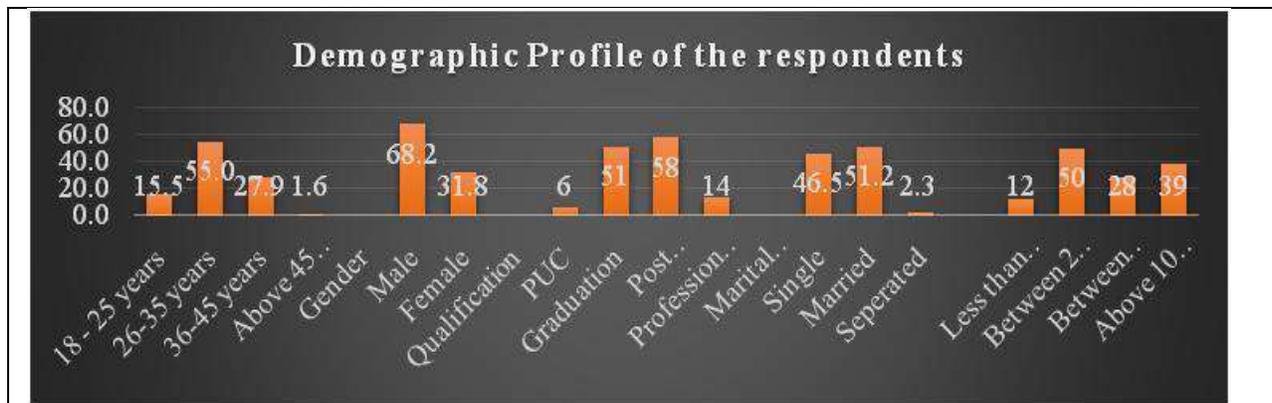
Chart 1 – Demographic Profile of the respondents

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Chart 2– Work Profile of the respondents
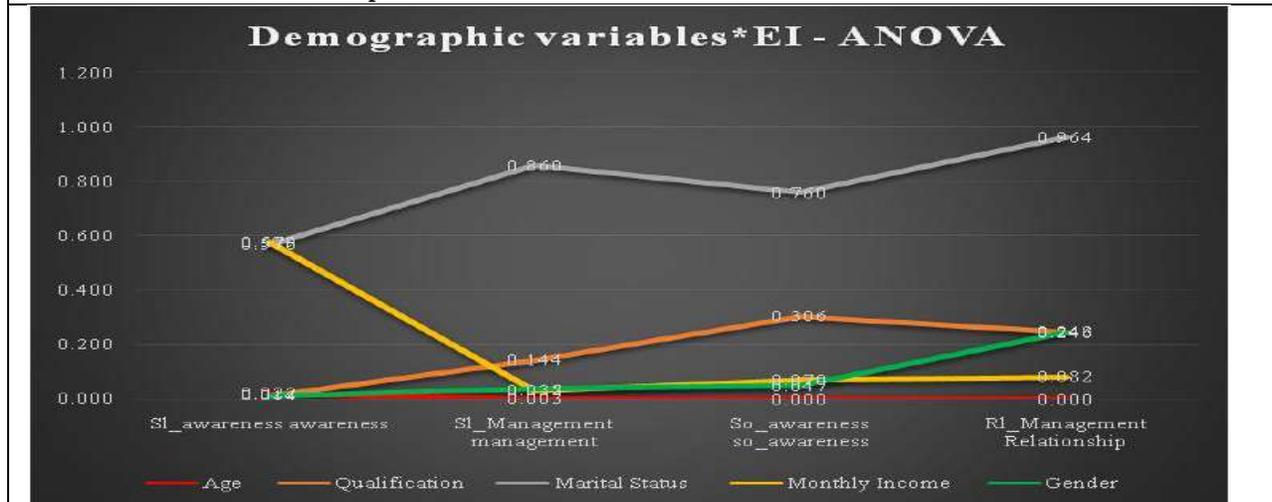
Chart 3- Demographic variables*EI - ANOVA - Significance values p =0.05
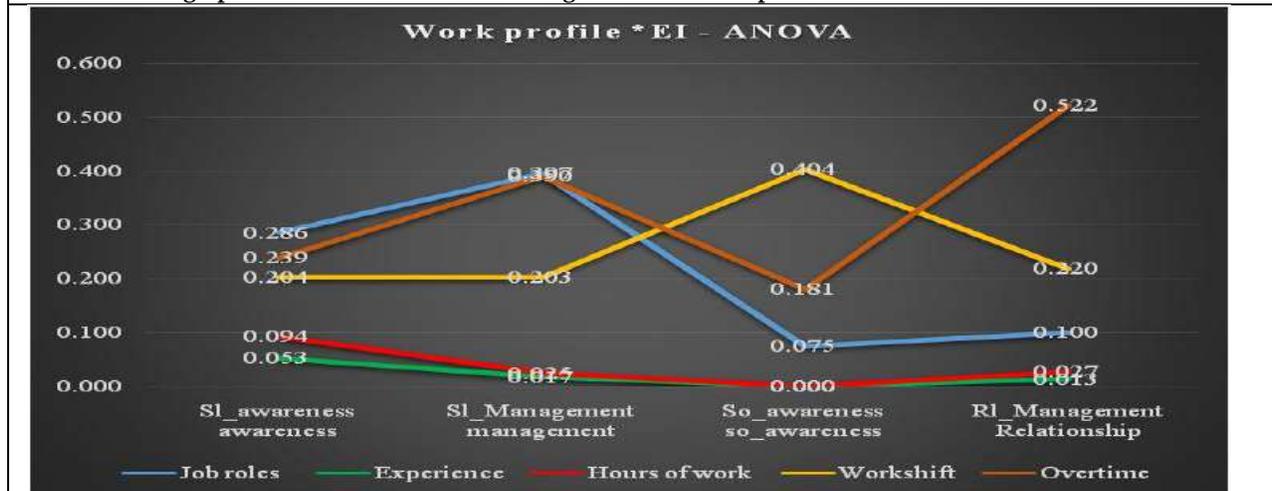
Chart 4- Work Profile *EI - ANOVA - Significance values p =0.05

RESEARCH ARTICLE

Analyzing the Supply Chain Management Process and the Impact of Information Technology in Organisational Marketing

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ABSTRACT

The introductory part highlights the connection of Supply chain management to Information technology in organizational marketing efficiency. The objectives, research questions and aim to denote the functional steps of the research study for more evaluation. The research aims to pertain to the advancement of IT and SCM and is the result of intricate interplays among multiple factors, emphasizing the significance and intricacy of the subject. The supply chain system and demand-supply model highlight the generals of this research work. In this study, researchers employ the Primary quantitative method to gather statistical data. This method yields numerical data that is essential for this research. Through a set of 10 survey questions to 55 respondents' researchers acquire valuable insights. The statistical results are instrumental in conducting hypothesis testing. The results of the hypotheses are discussed with the status of correlational behaviour among the variables. The resultant values of Descriptive and demographic analysis help the researchers to take significant decisive opinions regarding the research work. This segment explains the outcome of the research and elaborates on the critical impact of the objectives in relation to the result of the findings. The concluding part consists of the overall summary of the study and reflects the outcome of the elaborative discussion of the whole research work.

Keywords: Supply chain management, Informational technology, organisational market, production, efficiency

INTRODUCTION

Supply Chain Management (SCM) is pivotal in ensuring that products and services reach customers efficiently, on time, and at the desired quality. In today's dynamic business environment, the effective management of the supply chain has become a critical strategic imperative for organisations seeking to gain a competitive edge. On the other hand, Information Technology (IT), serves the purpose of optimizing the fluency of goods and services that are engaged with cost management and customer satisfaction (Flak, 2020). The nature of these two catalysts provides an in-depth exploration of the complex nature of organizational behaviour, underscoring the critical role that marketing strategies play in driving organizational success. As discussed by Min, Zacharia & Smith (2019), the advent of information technology has revolutionized supply chain management, transforming it from a linear and inflexible process to a dynamic and interconnected network that enables organizations to respond rapidly to shifting market demands. This interconnectedness has become the cornerstone of modern business, and organizations that embrace this approach would thrive in today's fast-paced, ever-changing world.

Figure 1 depicts the internal activities of the supply chain production process. As the figure reflects it goes through the procession of manufacturing, distribution and marketing stages which lead to the customary context from suppliers Eventually (Jonathan *et al*. 2021). Eco-friendly and sustainable technologies, together with technological gadgets and cutting-edge information technology, have become indispensable elements of supply-chain management in organisational business. These days, supply chains frequently compete with one another instead of individual businesses. According to Dubey, Gunasekaran, & Foropon (2022), when it comes to marketing a product or service, the role of information technology needs to be tailored to its nature. The type of information technology coordination that is needed depends on whether the product or service is functional or innovative. Choosing the right kind of coordination can give a supply chain a competitive edge. Thus, it is crucial to make the right choice.

Aim
In this research work the primary purpose is to analyze the systematic process of supply chain management and the effect of Information Technology in the field of Organisational Marketing.

Research Objectives
RO 1: To explore the affinity between information technology and supply chain performance in Organisational Marketing
RO 2: To determine the best practices for implementing information technology through supply chain management in Organisational Marketing
RO 3: To investigate the potential benefits of information technology in cost management and overall efficiency in Organisational Marketing
RO 4: To comprehend the significance of information technology in improving collaboration and communication in the supply chain for Organisational Marketing

Research Questions
The suggestible research questions are mentioned below:
RQ 1: What is the comprehendible relationship between SCM and IT in organisational Marketing?
RQ 2: What are the suitable implementing strategies for Information Technology through Supply chain Management?
RQ 3: What are the potential benefits of IT in cost management and efficiency measurement?
RQ 4: How to comprehend the significant strategies for IT in the improving aspect of collaboration and communication In organisational Supply chain marketing?

Hypothesis
H1: There is a positive bond between IT and Supply SCM to Organisational Marketing

H2: There is a considerable relationship between Information Technology and Cost management strategies
H3: There is significant bonding between the collaborative approach of SCM and organisational marketing

LITERATURE REVIEW

Evaluation of the Association of Information Technology and Supply Chain Management in Organisational Marketing
The effective integration of IT and SCM can help organizations optimize their supply chain processes, and align their marketing strategies with their supply chain capabilities. As opined by Lee *et al*. (2022), supply chain management (SCM) is a comprehensive and interconnected system that encompasses all the processes, from the procurement of raw materials from the manufacturer or producer to the delivery of the final product to the consumer. It involves a complex network of processes that are integrated and coordinated to ensure efficient and effective supply chain operations. Supply Chain Management (SCM) is the supervision of a system of linked businesses that provide goods and services to final customers. As depicted by Dehgani & Navimipour (2019), sharing information across various supply chain networks, helps the agents to work together to create integrated and well-coordinated supply chains for effective management. The information-sharing aspect also bolsters supply chain performance, while simultaneously mitigating risks through the optimization of processes and transactions.

The above figure suggests the critical objectives of the Supply Chain Management process that every Business must execute. Organisational Marketing is based on several counterparts of business planning, management, distribution and procurement (Irc, 2020). Businesses must execute a sequence of interdependent steps in a specific order to fulfil the goal of supplying goods and services to end users. These interlinked operations form a chain of actions, hence the term "Supply Chain." According to Basheer *et al*. (2019), it is a dynamic linkage that aligns the provision of goods and services with consumer demand. This interconnected process ensures that products and services are efficiently produced, transported, and delivered to meet the ever-changing demands of the market.

IT systems provide access to real-time data, which is vital for marketing strategies. As per the opinion of Katsikeas, Leonidou & Zeriti (2020), based on supply chain performance, consumer preferences and the circumstances of present market conditions, enable businesses to make well-informed decisions. This data-driven strategy aids in coordinating marketing initiatives with supply chain competencies. It helps to enhance the customer experience by enabling e-commerce platforms, customer relationship management (CRM) systems, and personalized marketing (Tallon *et al*. 2019). The proceedings circulate the sustainability efforts within the supply chain, which can be a significant selling point in marketing campaigns, especially for eco-conscious consumers.

Discussion of implementing strategies for Information Technology through Supply chain Management
Information Technology helps organizations to streamline their operations and improve work efficiency. Adopting the right IT strategies can enable businesses to differentiate themselves from contemporary competitors and gain a competitive advantage. Information technology offers the means to gather pertinent data, dissect it for in-depth analysis, and implement it for peak supply chain efficiency. Data is central to supply chain execution, serving as the foundation for informed decision-making by supply chain managers.

These strategies can help organizations to implement to leverage IT through supply chain management:
Execution of a Centralized System
Organisations benefit from having a centralised system because it gives them a single source of truth for all of the data related to their supply chain, which lowers mistakes, improves accuracy, and increases transparency. As stated by Tien, Phu & Chi (2019), organisations may easily manage their inventory levels, order amounts, and shipping tracking in real-time by using a centralised system.

Warehouse Operation

Optimizing warehouse operations is crucial for businesses that want to compete in today's fast-paced market. Fortunately, IT Solutions offers the perfect solution by automating key processes such as picking, packing, and shipping. Automation not only reduces the need for manual labour but also significantly improves efficiency, which ultimately translates into higher profits. As opined by Dash *et al*. (2019), incorporating a warehouse management system (WMS) can help businesses optimize space utilization, reduce waste, and improve order accuracy, all of which contribute to a more streamlined and profitable operation.

Demand-Driven Chain

Demand-driven supply chains aim to respond to customer needs in real time. Information technology tools such as demand sensing and demand planning enable organizations to predict demand with precision and inventory management. Figure 3 reflects the significant contents of demand and supply corrugation of Organisational objectives. Forecasting the market, creating an execution plan, level shift and promotional activities constitute the Demand stage. On the other hand, the Supply process as a whole contains the sub-operations of Allocation, sorting the products, scheduling and supply as per the lead time. As commented by Hallwood (2023), these approaches diminish the likelihood of both stock outs and surplus commodities, helping businesses maintain a delicate balance between supply and demand, enhancing customer satisfaction, and improving operational efficiency.

Elaboration of IT in improving collaboration and communication in SCM for Organisational Marketing

As retailers interact with customers throughout the supply chain, it's essential for them to have seamless integration, adaptability, and visibility. By linking their stock tracking tool, which is accessible to distributors, with their point-of-sale (POS) systems, retailers can streamline their operations and ensure they never run out of stock. According to Menon, & Shah (2019), by setting up a reorder point that automatically triggers an order once reached, retailers can streamline their processes even further and maintain consistent merchandise classes.

Information technology paves the role in improving collaboration and communication in the supply chain in certain ways:

Coordination and Collaboration

Information technology, which offers a centralised platform for communication and collaboration amongst all parties involved, is essential in improving supply chain coordination. In turn, this lessens the possibility of misunderstandings and makes sure that everyone is on the same page, which eventually improves production and efficiency. As opined by Hemant, Rajesh & Daultani (2022), collaborative planning, forecasting, and replenishment (CPFR) is a process that involves collaboration between trading partners to optimize supply chain performance. IT solutions including the operations of different software can help to improve communication, increase transparency, and reduce stock levels.

Automation and Customer Satisfaction

Information technology offers automation solutions capable of streamlining multiple supply chain functions, encompassing inventory control, order fulfilment, and shipment tracking. This not only lightens the burden on staff but also accelerates operations, boosting efficiency. As opined by Daqar & Smoudy (2019), automation's impact on marketing is substantial, as it empowers businesses to execute campaigns, customer interactions, and data analysis swiftly and with precision. The synergy between IT automation in supply chains and marketing amplifies productivity and customer satisfaction.

METHODOLOGY

In the context of methodology, primary data collection methods have been selected for fundamental and indispensable expertise in this research study. It helps to engage the rational quantitative value from the direct source adhering to the research objectives. As stated by Nayak & Narayan (2019), It enables the researchers to analyse and evaluate data more efficiently, providing insightful information about the topic. The results obtained from the research survey are statistically analysed using IBM's SPSS program. 10 survey questions regarding the research topic were circulated through Google Survey form among audiences and 55 respondents gave their helpful

opinions that resulted in the raw source of data analysis. The target Audiences are the leaders, departmental heads and managers of Industrial organisations. This customization ensures that the data collected is directly relevant to the study's specific goals. Positivism and deductive approaches are employed in the methodology section, shaping the foundation for this research. These methods are essential to the work for providing a well-organized framework and experimental diligence which help the researchers to explore efficiently and come to a conclusion.

Primary data's uniqueness relies on its originality and real-time reflection, These cannot be included from existing pre-existing sources. As opined by Udriyah, Tham & Azam (2019), researchers could adapt and manage theri primary findings based on the responses of the research process which would enable them to take quality control. In order to conduct research surveys, demographic analysis provides a broad understanding of the target population. On the other hand, descriptive analysis involves performing statistical analyses of the collected data to evaluate the relationships between different variables. Through the utilization of these analytical techniques, one can generate high-quality findings for their research. This study heavily relies on hypothesis testing, and the investigators are able to collect data in real time. After that, researchers may comprehend the role that IT and SCM play in organisational marketing with the use of this analysis of data technique. This research approach, which manipulates two sets of variables to gather data, is in line with the scientific process. Using this method ensures a comprehensive and empirically sound investigation of the topic by carefully examining the research questions and establishing causal relationships between variables.

Finding and Analysis
Demographic Analysis
Gender
Table 1 reflects the classification of the Gender of the participants as a demographic analysis in this research work. As the table suggests out of 55 participants 31 are male that falls into the majority of the participants, while 16 are female. There are another group of people who do not want to reveal their gender. These are sectioned as valid and cumulative percentages.
Figure 4 depicts the visual representation of the gender division through a pie chart. The data collection process includes the participation of 56.36% of male and 29.09% of female respondents. In addition, 29.09% of the total respondents belong to a group who do not want to reveal their gender for this research work. Active engagement of all genders denotes the unbias approach of survey execution.

Age Group
The above table presents the frequency of the age groups of the participants. The age range of participants in this study extends from 25 to 66 years old, covering a wide spectrum of opinions from different individuals. This diversity of perspectives enhances the quality of the analysis and outcomes of the study. Figure 5 explains the respondents' age division by the pie chart analysis. As the figure suggests the maximum of 36.36% of responders' age are between 35 and 45. People between the age of 25 to 35 holds 29.09% of the total responses. On the other hand, 21.82% of participants were aged between 45 and55 and the least number of people were in the group of 55 to 66 years. Age-related variances in viewpoints on personal experiences undeniably exist, providing researchers with the means to formulate more precise conclusions.

Designation
Table 3 offers a breakdown of the response rate from 55 participants, segmented by their respective job roles within organizational marketing. Participants employed in different designations would have multiple opinions regarding their job roles, this would help the researchers to make their decisions by analysing all the raw opinions.
Figure 6 discusses the respondent's designation in percentile form in different sections of statistical analysis. 36.36% of the responders are Assistants and 29.09% of the total responders belong to the job role of Marketing Head. The responder with the designation of manufacturing leader holds 20% of the responses. On the other hand, Logistic Managers hold 14.55% of the overall responses.

Descriptive Statistics
Table 4 illustrates the results of the descriptive statistics analysis in relation to the variables. The table highlights the mean and standard deviation values for each variable. The mean value of the dependent variable in this analysis is

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4.054, while the standard deviation is 0.80319. The kurtosis value of the dependent variable is 1.212. And the other three independent variables are -.624, 1.970 and 1.987 respectively. As all the data are under the range of +/- 2 this table denotes the worth of the data set and justifies the usefulness in the research analysis. The N value of 55 expresses the mean value of three independent variables as 9.07, 9.45 and 8.43. The standard deviation value of the second independent variable is less than 0 depicting the significance of the research strategy.

Hypothesis 1

Table 5, displayed above, presents the outcomes of a linear regression analysis involving independent variable 1 (IV1). This analysis encompasses various measurement scales, such as the "model summary" table, ANOVA, and coefficient of correlation tables, delivering a thorough assessment of the regression values and their statistical significance. The noteworthy aspect of this finding is the p-value of 0.00, indicating a strong and valid correlation among the variables. This states that the variables have a positive bond among themselves. The R value is .541 this is near to the positive value of 1 and it shows a positive relation.

Hypothesis 2

Table 6 expresses the result of the regression analysis of the second hypothesis that follows a similar pattern to the former table. This table presents the significant value as 0.02 which is less than the general parameter of 0.05, it indicates the variables are near to correlation and they possess a significant positive relationship among themselves. The Beta value of .401 assesses the counterpart of the correlational aspect of the variables. The F value of 10 denotes the significance of the justified analysis of this hypothesis.

Hypothesis 3

Table 7 provides an overview of the results derived from a linear regression analysis, focusing on the evaluation of the third hypothesis. In this specific context, it's worth noting that the significant value in the coefficient table, standing at 0.721, is notably higher than the corresponding correlational value. This discrepancy suggests that within this particular segment, the variables under consideration do not exhibit substantial correlations or strong interdependencies. The R-value of 0.049 dictates the negative connection of the variables of the data range. As per the notion of Lee & Falahat (2019), a strong correlation does not prove that one variable causes the other but it only indicates a relationship between them. Other factors and research methods are necessary to establish causation while the F value in Anova is 0.129 justifying the worth of analysis for getting the deceive response from the researchers.

Correlation Test

Based on Table 8, it can be observed the correlation status between the first, second and third independent variables. The values suggest that there is a significant statistical relationship between the dependent and independent variables. This is supported by the 2-tailed significant value being less than 0.05, which is the commonly accepted threshold for significance. The direction of the association is indicated by the correlation coefficient's sign, which can be either positive or negative. Whereas a negative correlation indicates that as one variable rises, the other tends to fall, a positive correlation indicates that when one variable rises, the other tends to rise as well. IV1 When analysed with IV3 the value presents 0.017 with a correlational status and positive connection. On the other hand, the sig. value of IV2 and IV1 presents as 0.434 denoting the non-relational value to correlation as it is much higher than 0.05.

DISCUSSION

The way different components interact in today's corporate environment highlights how important supply chain management (SCM) and information technology (IT) are to organisational marketing. The relationship between these components determines the actual conditions in which enterprises function. As per the opinion of Dahlmann & Roehrich (2019), it provides businesses with the tools they need to engage customers, automate processes, and make data-driven decisions in an increasingly digitally linked world. The correlational values of the major hypothesis result in assuring the effect of SCM in ensuring efficient logistics, timely delivery, and well-managed inventories. As per the suggestion of Ellram, & Murfield (2019), organizations understand that the collaboration between IT and supply chain management is crucial for optimizing their supply chain and aligning it with customer demands and

market trends. This enables them to offer a seamless customer experience, adapt to market changes, and gain a competitive edge. As a result, both IT and SCM are essential for organizational success in the context of marketing. The emerging landscape of connected organisations, as supported by current research findings, promises to usher in a new era of marketing intelligence. As commented by Tu & Wu (2021), This paradigm shift is characterized by a transition towards heightened demand-driven operations, offering significant gains in terms of competitive advantage. There are multiple levels of supply chain excellence including, business links, visibility, collaboration, velocity and so on. Each of these leads to the advancement of organisational marketing. Every department or division within an organisation often functions autonomously, using different approaches depending on the needs of the application. However, as per the view of Al-Zaqeba *et al.*(2022), creating visibility is the first step towards smooth information exchange. The deliverance of linkages to information to the stakeholders assess how the supply chain is operating, this strategy helps to mitigate unforeseen events in the supply chain. Collaboration thrives when technology and genuine partnerships are effectively employed. Synthesis is a continuous improvement process that unifies and combines the many aspects of a supply chain. As Fatorachian & Kazemi (2021) suggest, in order to secure consumer satisfaction, this method harnesses the force of change to meet the always-changing marketplace. Utilizing the demand-driven approach, businesses can capture customer purchase data at the point of sale and efficiently distribute it to all trading partners throughout the entire supply chain. This allows for seamless communication and collaboration, regardless of individual marketing strategies (Krizanova *et al.* 2019). Real-time monitoring and response capabilities are one of the transformative qualities of this newfound intelligence that enable organisations to detect disruptions and deviations from the norm instantly.

The data collection procedure employed in this research holds immense value as it actively justifies the impact of information technology. By providing numerical pieces of Information Technology and Supply Chain Management, this method helps to strengthen the study's findings. Moreover, subjectivity is the main feature of this data collection method, which further enhances the credibility of the research. As stated by Kurochkina *et al.* (2019), using this approach promotes organisational marketing by simplifying expert decision-making and emphasising decision-marketing techniques. The integration of Information Technology (IT) is now deemed a fundamental necessity in the management of these intricate networks, and it has shown a strong correlation with substantial enhancements in supply chain efficiency. This relationship hinges on the innate characteristics of Small and Medium-sized Enterprises (SMEs) with the tactics of marketing brochures. As stated by Shekarian & Mellat (2021), this often encompasses flexibility, swift determination-making, and a collaborative spirit among the marketing employees. Additionally, the Marketing aspect depends on the variability of Customer Relationship Management. Marketing processes encompass a series of determinations, including the selection of target customers, strategies for consumer engagement, service offerings and cost management, As concerned by Korneeva, Hönigsberg & Piller (2021), this customized approach leverages the inherent strengths of Small and Medium-sized Enterprises (SMEs) to optimize the advantages of Information Technology within the supply chain management structure. In order to close a deal, the salesman or the client might need to configure orders from a variety of choices and features (Harris *et al.* 2020). The sales process also requires responsibilities like obtaining client order details and estimating the duration of delivery.

CONCLUSION

In the concluding note, it can be stated that Information technology and supply chain management have significantly impacted organizational marketing in a variety of ways. They have enabled organizations to better understand their consumers, optimize their supply chains, and enhance their marketing strategies. With the utilisation of data analytics and predictive modelling, organizations can gain valuable insights into customer behaviour and preferences, allowing them to tailor their products and services to meet the needs of their target audience. Competition between supply chains has increased significantly, and technology has played a crucial role in enhancing profitability and efficiency by strengthening supply chains. As a result, firms are no longer competing against each other but rather, supply chains are pitted against one another. This work permits the researchers to

implement SPSS software for a rigorous assessment of the statistical values from the collected resources. provide a comprehensive analysis of the research study to enhance readers' understanding of the impact of IT and SCM in rational ways to concave the path of organisational Marketing. Moreover, advancements in technology have enabled supply chains to become more agile, responsive, and resilient. For example, the use of automation and robotics has increased productivity, reduced errors, and improved safety. Additionally, data analytics and artificial intelligence have enabled firms to make more informed decisions, optimize their operations, and enhance customer satisfaction.

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Table 1: Gender

		Frequency	Percent	Valid Percent	Cumulative Percent
	1. What is your gender?				
Valid	Female	16	29.1	29.1	29.1
	Male	31	56.4	56.4	85.5
	Prefer not to say	8	14.5	14.5	100.0
	Total	55	100.0	100.0	

(Source: IBM SPSS)

Table 2: Age Group

		Frequency	Percent	Valid Percent	Cumulative Percent
	2. What is your age group?				
Valid	25 to 35 years	16	29.1	29.1	29.1
	35 to 45 years	20	36.4	36.4	65.5
	45 to 55 years	12	21.8	21.8	87.3
	55 to 66 years	7	12.7	12.7	100.0
	Total	55	100.0	100.0	

(Source: IBM SPSS)

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Table 3: Designation

3.What is your Designation ?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Assistant	20	36.4	36.4	36.4
	Logistic Manager	8	14.5	14.5	50.9
	Manufacturing Leader	11	20.0	20.0	70.9
	Marketing Head	16	29.1	29.1	100.0
	Total	55	100.0	100.0	

 (Source: IBM SPSS)

Table 4: Descriptive analysis of different variables

Descriptive Statistics

	N	Minimum	Maximum	Sum	Mean	Std. Deviation	Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error
DV1	55	2.00	5.00	223.00	4.0545	.80319	1.212	.634
IV1	55	7.00	10.00	499.00	9.0727	1.18407	-.624	.634
IV2	55	7.00	10.00	520.00	9.4545	.89893	1.970	.634
IV3	55	5.00	10.00	464.00	8.4364	1.25851	1.987	.634
Valid N (listwise)	55							

 (Source: IBM SPSS)

Table 5: Linear regression analysis for Hypothesis 1

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
1	.541ª	.293	.279	.68186	.293	21.927	1	53	.000	2.221

ANOVAª

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	10.195	1	10.195	21.927	.000[b]
	Residual	24.642	53	.465		
	Total	34.836	54			

Coefficientsª[l]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.725	.717		1.012	.316
	IV1	.367	.078	.541	4.683	.000

 (Source: IBM SPSS)
 Table 6: Linear regression analysis for Hypothesis 2

Model Summary^b

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
1	.401ª	.161	.145	.74268	.161	10.158	1	53	.002	1.824

ANOVA^a

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	5.603	1	5.603	10.158	.002ᵇ
	Residual	29.233	53	.552		
	Total	34.836	54			

Coefficients^a

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.667	1.068		.624	.535
	IV2	.358	.112	.401	3.187	.002

(Source: IBM SPSS)

Table 7: Linear regression analysis for Hypothesis 3

Model Summary^b

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
1	.049ª	.002	–.016	.80975	.002	.129	1	53	.721	1.786

ANOVA^a

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	.085	1	.085	.129	.721ᵇ
	Residual	34.752	53	.656		
	Total	34.836	54			

Coefficients^a

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	3.789	.747		5.074	.000
	IV3	.031	.088	.049	.359	.721

(Source: IBM SPSS)

Table 8: Correlation test between a dependent variable and independent variables

Correlations

		DV1.1	DV1	IV1	IV2	IV3
DV1.1	Pearson Correlation	1	1.000**	.541**	.401**	.049
	Sig. (2-tailed)		.000	.000	.002	.721
	N	55	55	55	55	55
DV1	Pearson Correlation	1.000**	1	.541**	.401**	.049
	Sig. (2-tailed)	.000		.000	.002	.721
	N	55	55	55	55	55
IV1	Pearson Correlation	.541**	.541**	1	.108	-.320*
	Sig. (2-tailed)	.000	.000		.434	.017
	N	55	55	55	55	55
IV2	Pearson Correlation	.401**	.401**	.108	1	-.113
	Sig. (2-tailed)	.002	.002	.434		.411
	N	55	55	55	55	55
IV3	Pearson Correlation	.049	.049	-.320*	-.113	1
	Sig. (2-tailed)	.721	.721	.017	.411	
	N	55	55	55	55	55

(Source: IBM SPSS)
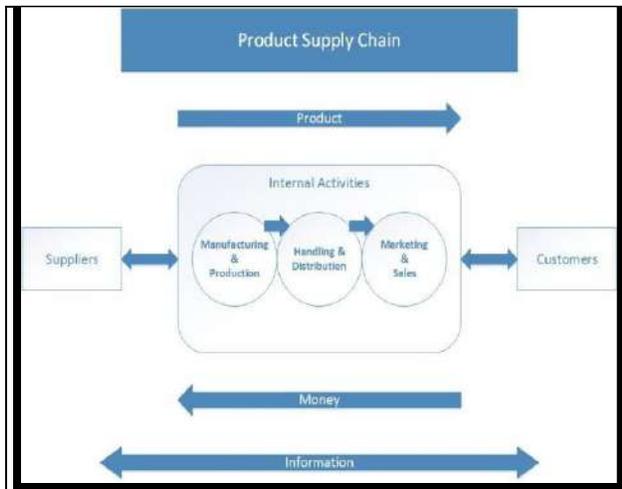
Figure 1: General Supply Chain schematic
(Source: Jonathan *et al*. 2021)

Figure 2: Objectives of SCM in Organisational Marketing (Source: Irc, 2020)

Figure 3: Demand and Supply Model of Organisational Operations (Source: Tompkins, 2023)
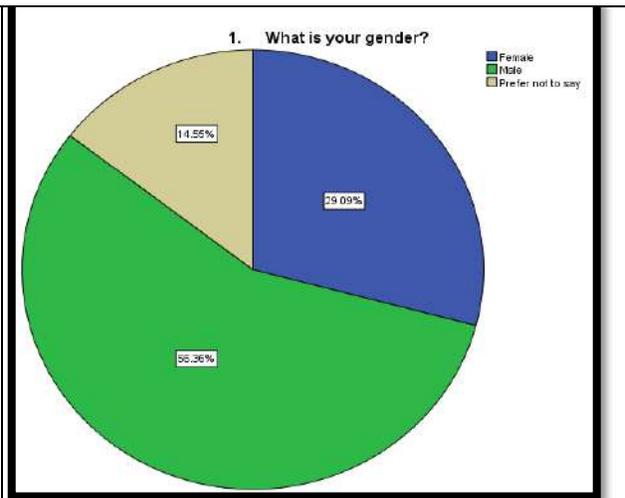
Figure 4: Gender (Source: IBM SPSS)
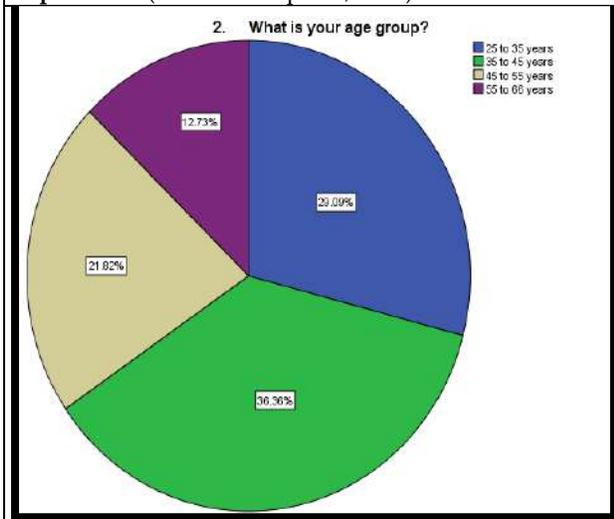
Figure 5: Age Group (Source: IBM SPSS)
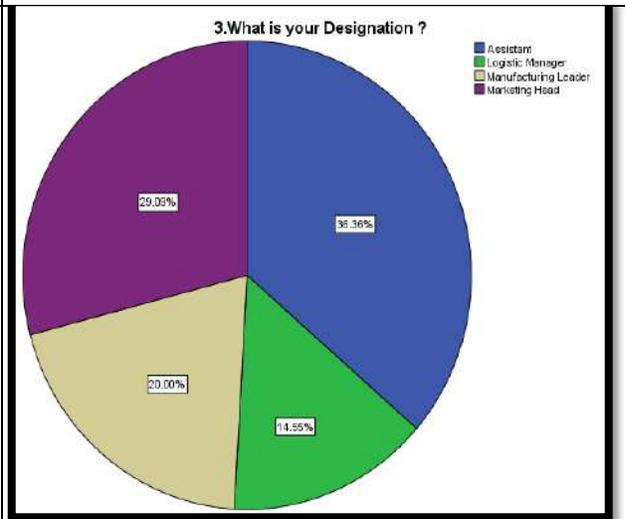
Figure 6: Designation (Source: IBM SPSS)

RESEARCH ARTICLE

An Exploratory Study of Issues and Challenges on Tax Policy of Virtual Assets

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ABSTRACT

This study aims to analyze the issues that are associated with the tax policy of virtual assets. The purpose of this exploratory study is to delve into challenges that are associated with the taxation of virtual assets. The taxation of virtual assets is an unexplored area of tax policy. The transactions occur on decentralized block chain networks to eliminate the need for intermediaries such as banks and other virtual tax. This decentralization fundamentally alters the landscape for tax authorities. This conventional mechanism for tracking financial transactions has become less applicable."Optimal Taxation Theory '' can be applied to tax policy for virtual assets that are associated with public finance and economics A survey was conducted with 55 individuals that can be analyzed through SPSS software. Purposive sampling was used to pick each participant. with the aid of SPSS software, researchers can analyze data numerically. Therefore, based on demographic analysis, and statistical related analysis, researchers can analyze collected data. The taxation of virtual assets is an unexplored area of tax policy. A critical knowledge gap can be addressed in informed policymaking. This study aims to shed light on the intricacies of taxing virtual assets. These are examining the unique characteristics of these assets that pose challenges to conventional tax frameworks in virtual assets.

Keywords: Taxation, Virtual assets, Policymaking, Digital Landscape

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INTRODUCTION

The emergence of virtual assets has reshaped traditional notions of wealth, commerce, and financial transactions in the global economy. Virtual assets include cryptocurrencies, non-fungible tokens (NFTs), and digital tokens. These have gained unprecedented popularity. It presents both opportunities and challenges for policymakers all over the world. Digital assets are needed to continue to proliferate for the governments. These are grappling to establish comprehensive tax policies that can effectively navigate the complexities of this nascent ecosystem. The purpose of this exploratory study is to delve into challenges that are associated with the taxation of virtual assets. As per the views of Amponsah, Adebayo &Weyori. (2021), the taxation of virtual assets is an unexplored area of tax policy. A critical knowledge gap can be addressed in informed policymaking. This study aims to shed light on the intricacies of taxing virtual assets. These are examining the unique characteristics of these assets that pose challenges to conventional tax frameworks in virtual assets. The main challenge lies in the decentralized nature of many virtual assets. These are crypt currencies like Bitcoin and Ethereum. Traditional taxes were designed for centralized financial systems. These are making it difficult for authorities to regulate transactions occurring on blockchain networks. The pseudonymity is associated with virtual asset transactions to enforce tax compliance. Another challenge arises from the rapid evolution of virtual asset technologies in diverse forms. Saka, Oshika, &Jimichi (2019) opined that non-fungible tokens represent digital assets that have distinct tax implications. These are compared to fungible cryptocurrencies for creating a tax policy. It accommodates the nuances that require a nuanced understanding of the technology for applications in the tax market.

The cross-border nature of virtual asset transactions complexities in taxation for occurring on a global scale. Digital wallets are accessible in a world that faces challenges in determining when taxable events take place to levy taxes. It provides insights that inform the development of adaptive taxation frameworks in the rapidly evolving digital economy. As per the views of Amaeshi, Adi&and Ikiebey (2019), the governments grappling with these challenges are growing because of international cooperation. It can standardize tax policies that are related to virtual assets. These are collaborative efforts to foster a harmonized approach. It can ensure fair taxation to minimize regulatory arbitrage that promotes a level playing field for market participants. Hence, this exploratory paper wants to contribute to minimising the issues that are surrounding the taxation of virtual assets. With the unique characteristics, technological complexities, and international dimensions of virtual assets, policymakers can effectively and equitable tax policies in this rapidly evolving digital landscape.

Aim
Aim of this study is toanalyze the issues that are associated with the tax policy of virtual assets at different landscape in tax consideration .

Research Objectives
- To analyse the decentralized nature of virtual assets to develop traditional tax structures in market.
- To examine an evolving landscape at virtual asset technologies at tax considerations. At different landscape.
- To explore dynamics of virtual assets that is needed to understand the challenges in taxation sector.
- To investigate apotential barriersfor international collaboration as well as standardizing tax policies of this virtual assets.

Research Questions
- How is it to investigate nature of virtual assets for traditional tax structures in the market?
- What is the main procedure for examining that is needed for evolving landscape of virtual asset at tax considerations?
- How is it to explore the cross-border dynamics of virtual assets in jurisdictional taxation in market?
- What is the main procedure to investigate the potential for international collaboration that are collaborate with standardizing tax policies for virtual assets?

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Hypothesis

- H1: There is a positive relationship between virtual assets and traditional tax frameworks.
- H2: There is a significant relationship between unique tax implications and the virtual asset ecosystem.
- H3: There is a strong interconnection between cross-border transactions of virtual assets and jurisdictional taxation.
- H4: There is a positive relationship between the development of standardized tax policies and virtual assets.

LITERATURE REVIEW

Decentralized Nature of Virtual Assets for Traditional Tax Structures

The decentralized nature of virtual assets has a profound challenge to traditional tax structures. These are inherently designed for centralized financial systems of cryptocurrencies like Bitcoin and Ethereum. The transactions occur on decentralized blockchain networks to eliminate the need for intermediaries such as banks and other virtual tax. According to Miriti& Marion Nekesa (2021), decentralization fundamentally alters the landscape for tax authorities. This conventional mechanism for tracking financial transactions has become less applicable. The significant consequence of decentralization is the difficulty of enforcing tax compliance. Traditional financial systems are needed for centralized databases and financial institutions. Authorities can easily access to track transactions and identify taxable events. Virtual assets are operating on decentralized networks the transparency of financial activities diminishes. These are leading to challenges in identifying and monitoring taxable events.

The absence of a central governing authority is needed for authority in virtual asset ecosystems. It makes it challenging for tax authorities. These are needed to establish clear jurisdiction at different enforcement mechanisms. It is needed for determining the location of a taxable event. Virtual assets are transacted globally without adherence to geographical boundaries to have a decentralized nature (Školkay, 2020). This efficient collection of taxes can raise questions about the fair. It can uniform application of tax policies across different jurisdictions to develop as policymakers. The need for innovative solutions is needed to reconcile the decentralized nature of virtual assets. Traditional tax frameworks become increasingly evident in traditional tax structures.

The Evolving Landscape of Virtual Asset Technologies at Tax Considerations

The evolving landscape of virtual asset technologies is needed for intricate challenges. These are considerations for tax policies for demand a nuanced examination of distinctive features. As per the opinion of Alderhell & Hamad (2021), the rise of "non-fungible tokens (NFTs)" is a unique digital asset that represents ownership. It can represent proof of authenticity for different digital and physical items. The tax implications of NFTs are needed to extend beyond traditional notions. The uniqueness and diverse applications necessitate tailored approaches for valuing NFTs for tax purposes. It can pose a challenge due to their subjective nature and unique attributes. The absence of standardized valuation methodologies is needed for determining the fair market value. Thus, it becomes crucial for tax assessment in a dynamic environment.

Virtual asset technologies require tax policies to adapt rapidly and policymakers to stay ahead of emerging challenges. These are needed such as the potential introduction of decentralized finance (DeFi) platforms. Associated tax implications are the versatility of virtual assets from cryptocurrencies to decentralized applications (DApps). It demands a comprehensive understanding of their varied applications as well as tax authorities (Arab *et al*., 2022). These are needed to distinguish between virtual assets used for investment for facilitating transactions. Therefore, these are underpinning decentralized applications, each with its unique tax considerations. Virtual asset technologies are focused on the advent of NFTs and other innovations. All necessitates a flexible and forward-thinking approach to tax policies. Policymakers are intricacies of valuation and rapid technological advancements. Diverse applications of virtual assets are considered to formulate tax frameworks for the dynamic nature of this burgeoning ecosystem.

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Explore the Cross-Border Dynamics of Virtual Assets to Understand the Challenges In Jurisdictional Taxation

Cross-border in the realm of virtual introduction for jurisdictional taxation. These are reshaping traditional notions of territorial tax enforcement at virtual assets, such as cryptocurrencies and non-fungible tokens (NFTs). These operate seamlessly across borders rendering conventional tax boundaries obsolete. The significant challenge is determining the location of a taxable event like virtual assets that exist in a decentralized. As per the opinion of Dastidar& Banerjee (2020), global ecosystems are making it challenging for tax authorities to pinpoint the jurisdiction. The lack of standardized international tax regulations for virtual assets exacerbates the challenge of varying classifications of virtual assets across jurisdictions. It can lead to inconsistencies in tax treatment for creating opportunities at regulatory arbitrage. These are complicating efforts to ensure fair and equitable taxation.

The mobility in virtual asset transactions complicates cross-border tax enforcement and virtual asset holders can easily transfer assets between digital wallets across different jurisdictions. These are evading jurisdiction-specific tax obligations in the global and decentralized nature of block chain technology. Therefore, it makes any single jurisdiction to assert control over these transactions. According to Robert *et al*. (2023), Cross-border dynamics of virtual assets underscore the imperative for international collaboration. The development of standardized frameworks is needed to address jurisdictional challenges without concerted efforts. These are needed to harmonize tax policies globally. Jurisdictions can struggle to effectively tax virtual asset transactions that ensure the integrity of their tax systems.

Investigate the Potential for International Collaboration in Standardizing Tax Policies for Virtual Assets

The increasing prominence of virtual assets in the global economy examines international collaboration in standardizing tax policies. The cross-border nature of virtual asset transactions transcends traditional tax jurisdictions. These are prompting recognition among policymakers for a harmonized approach. As per the views of Bucea-Manea-Țoniş *et al*. (2021), compelling aspects are needed to support international collaboration. These are needed to prevent regulatory arbitrage at inconsistent tax policies across jurisdictions. It can create opportunities for individuals and businesses that are needed to exploit differences in taxation. The effectiveness of individual tax systems can mitigate these risks. These risks are fostering a level playing field for market participants.

On the other hand, decentralized assets pose challenges in the global. All issues such as defining taxable events are needed for establishing valuation methodologies. These are addressing enforcement hurdles to require collective expertise. These collaborative efforts are facilitating the development of robust. It is needed to adapt tax policies that accommodate the dynamic nature of virtual asset technologies. The international community is recognizing the transnational implications of virtual assets (Moncef& Monnet Dupuy, 2021). This common ground in forums like the "Organisation for Economic Co-operation and Development (OECD)". These are fostering collaboration and c address the challenges associated with taxing virtual assets. These are laying the foundation for a cohesive global framework for effective taxation in this evolving digital landscape.

Theoretical Implication
Optimal Taxation Theory

"Optimal Taxation Theory " can be applied to tax policy for virtual assets that are associated with public finance and economics. These are explored to design tax policies that can maximize the social welfare of virtual assets. As per the views of Farhi & and Gap (2020), the optimal taxation theory can be employed to determine the most equitable way. All assets are needed for considering their unique characteristics that impact economic assets. This theory of elasticity of demand, the distributional effects of taxes, and the potential distortions caused by taxation. In the case of virtual assets, where decentralization, anonymity. Application of this theory isoptimal tax structure that is needed to require considering the international dimensions. All technological aspects and potential behavioural factors are needed for the responses of participants in the virtual asset ecosystem (Akhmetshin *et al*., 2019). Applying the optimal taxation theory is to access virtual assets that involve assessing taxes. It can impact economic efficiency, market behaviour, and overall societal well-being. This theoretical framework provides for designing tax policies. These are maintained to balance the need for revenue generation to foster a fair.

METHODOLOGY

The principal quantitative method chosen by the study has been used for both data collection and analysis. The main technique of data collecting is beneficial since it gathers real data sets from pertinent individuals. To obtain data for the study, a survey was conducted with 55 individuals. Purposive sampling was used to pick each participant since it can help select only pertinent responses (Huang *et al.,* 2023). The study has also been able to choose participants who work from home as employers or workers thanks to this technique. In addition, ten questions on the survey's questionnaire focused on demographic data, with the remaining questions about the research variables (Sileyew, 2019). In addition, SPSS was employed as a statistical tool in the study's data analysis phase to examine the gathered data set. It is needed to assess the variables and their relationships, the statistical tests have included regression, correlation, and descriptive tests.

Findings
Demographic Analysis
Gender
Table 1 helps to analysethat, 34 male respondents are taken part in this process. Therefore, 12 frequencies are carried out by male percipients. Moreover, with the aid of this study, it has to be highlighted that, 4 candidates are not able to take part in this data collection section. Therefore, with the aid of this demographic analysis, brief discussion about tax policies has to be identified. Figure 5 helps to identify the response rate of the participants. As per this table, 68.0% is the maximum response rate and it is carried out by female category. Therefore, male respondents have 24.0% response rate. With the aid of this response rate, researchers can find out the impact of tax policies on virtual assets.

Age Group
The frequency of participants by age group is the basis for Table 2. Twenty of the respondents are in the age range of 20 to 35. Consequently, 23 respondents fall into the 35–50 age range. Additionally, there are six frequencies among participants in the 50–65 age group. Additionally, a single frequency is conducted with participants 65 years of age and older. Researchers are able to determine the significance of this study based on the responses from the 50 participants. Thus, with the help of this research study, the relationships between the variables are also discussed in detail. Figure 6 highlights the participants' response rate according to age group. The age group of 35 to 50 years old accounts for the largest percentage of response rate respondents. Consequently, the participant age group over 65 had the lowest response rate, which is 2.0%.

Income level
Table 3 shows the participants' income range. This table makes it easier to see which 14 participants fall into the $10,000–$20,000 income bracket. Consequently, 18 responders fall into the income range of 20,000 to 35,000. Following that, respondents with incomes between $35,000 and $50,000 have 14 frequencies. Consequently, participants with incomes above $50,000 participate in 4 frequencies. It is necessary to determine the respondents' response rate according to their income range with the help of Figure 6. The table indicates that the participants with the highest response rate fall into the income range of 20,000 to 35,000. As a result, individuals with the lowest response rate fall into the income range of over $50,000.

Statistical Analysis
Descriptive Analysis
Table 4 was made using a descriptive analysis of the four parameters mentioned. Based on this statistical analysis, the "minimum, maximum, and mean values" of the factors are indicated. Consequently, the "standard deviation" value of the variables is indicated in this table. The "mean" and "standard deviation" values of the second factor are 4.04 and.693, respectively, since the first factor's "mean value" is 7.43 and its "standard deviation" is 1.38. After that,

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the third variable's "standard deviation value" is.779, with "the mean value" being 4.20. The "mean value" of the last variable is 4.09.

Hypothesis 1

Table 5 highlights the importance of hypothesis testing. This table indicates that the significance value is 0.017 and the "R value" is.321. Furthermore, this table must be used to draw the conclusion that international cooperation is necessary for tax policy.

Hypothesis 2

The results of this second hypothesis test force us to draw the conclusion that there is a strong correlation between enhanced organizational stability and more stringent HR compliance measures. According to this table, this variable's "t value" is -2.910 since its "R value" is.371.

Hypothesis 3

Hypothesis 3 emphasizes the third variable's regression analysis. This analysis's "sig value," which is.917, indicates that Digital wallets are accessible in the world that faces challenges for determining when taxable events take place to levy taxes. Consequently, the "R square value" is .000 according to this table, where the "R value" is.014 as well.

Correlation Test

Table 8 is based on the co-relation value between the variables. This table shows that the first factor's sig value is.017, indicating that the variables do not correlate. Consequently, the sig value of the second factor is.005, indicating that there is a relationship between the two variables. Lastly,.971, the substantial value of the third factor, likewise has a considerable existence. This exploratory study aims to investigate the difficulties related to the taxation of virtual assets. Thus, the relationship between the dependent and independent variables is determined with the help of this study.

DISCUSSION

Overall discussion of this topic has to be identified here. As per this study, it has to be identified that, the emergence of virtual assets has reshaped traditional notions of wealth, commerce, and financial transactions in the global economy. Virtual assets include cryptocurrencies, non-fungible tokens (NFTs), and digital tokens. These have gained unprecedented popularity. It is presenting both opportunities and challenges for policymakers all over the world (Akhmetshin *et al*., 2019). Therefore, in the introduction section, aim of the research study has been identified. Therefore, objectives of the research are discussed, based on this, research questions are generated. With the aid of this section, researchers are capable to noticed that, the cross-border nature of virtual asset transactions complexities in taxation for occurring on a global scale. Digital wallets are accessible in the world that faces challenges for determining when taxable events take place to levy taxes. It provides insights that inform the development of adaptive taxation frameworks in the rapidly evolving digital economy. After that, in the literature review section, researchers are able to create topic related themes which helps to discuss the overall research topic. As per this section, researchers are able to know that, The significant consequence of decentralization is the difficulty for enforcing tax compliance. The traditional financial systems are needed for centralized databases and financial institutions (Alderhell& Hamad, 2021). Authorities can easily access to track transactions and identify taxable events. Virtual assets are operating on decentralized networks that transparency of financial activities diminishes. These are leading to challenges in identifying and monitoring taxable events.

Data collection process is analyzed within the methodology section. Therefore, in this study, primary quantitative method is used. After that, accuracy of the collected data has to be highlighted by this process. Moreover, statistical information's about the research study has to be generated with the aid of this methodology section. SPSS software helps to analyze statistical data, which helps to collect valuable information about this study. On the other hand, decentralized assets pose challenges in the global. All issues such as defining taxable events are needed for

establishing valuation methodologies (Amaeshi, Adi &Ikiebey, 2019). These are addressing enforcement hurdles to require collective expertise. These collaborative efforts are facilitating the development of robust. It is needed to adapt tax policies that accommodate the dynamic nature of virtual asset technologies.

CONCLUSION

It can standardize tax policies that are related to virtual assets. These are collaborative efforts to foster a harmonized approach. It can ensure fair taxation to minimize regulatory arbitrage that promotes a level playing field for market participants. Hence, this exploratory paper wants to contribute to minimize the issues that are surrounding the taxation of virtual assets. The unique characteristics, technological complexities, and international dimensions of virtual assets, policymakers can effectively and equitable tax policies in this rapidly evolving digital landscape.

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Table 1: Gender

Gender					
Valid		Frequency	Percent	Valid Percent	Cumulative Percent
	Male	34	68.0	68.0	68.0
	Female	12	24.0	24.0	24.0
	Prefer not to say	4	8.0	8.0	8.0
	Total	50	100.0	100.0	

(Source: SPSS)

Table 2: Age Group

Age					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	20 to 35 years	20	40.0	40.0	40.0
	35 to 50 years	23	46.0	46.0	46.0
	50 to 65 years	6	12.0	12.0	12.0
	Above 65 years	1	2.0	2.0	2..0
	Total	50	100.0	100.0	

(Source: IBM SPSS)

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Table 3: Income range

		Frequency	Percent	Valid Percent	Cumulative Percent
				Income level	
Valid	10000-20000	14	28.1	28.1	28.1
	20000-35000	18	36.0	36.0	36.0
	35000-50000	14	28.0	28.0	28.0
	Above 50000	4	8.3	8.3	8.3
	Total	50	100.0	100.0	

(Source: IBM SPSS)

Table 4: Descriptive analysis of the variables

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
DV	55	4.00	9.00	7.2000	1.32497	-.730	.322	.135	.634
IV1	55	3.00	9.00	7.4364	1.38462	-1.666	.322	3.849	.634
IV 2	55	3	5	4.04	.693	-.048	.322	-.848	.634
IV 3	55	2	5	4.20	.779	-1.345	.322	2.521	.634
IV 4	55	3	5	4.09	.674	-.109	.322	-.729	.634
Valid N (listwise)	55								

(Source: IBM SPSS)

Table 5: Regression analysis of variable

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.321[a]	.103	.086	1.26664	1.678

a. Predictors: (Constant), IV1
b. Dependent Variable: DV

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	9.768	1	9.768	6.088	.017[b]
	Residual	85.032	53	1.604		
	Total	94.800	54			

a. Dependent Variable: DV
b. Predictors: (Constant), IV1

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	9.484	.941		10.075	.000
	IV1	-.307	.124	-.321	-2.467	.017

a. Dependent Variable: DV

(Source: IBM SPSS)

Table 6: Hypothesis Testing

Model Summary^b

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.371^a	.138	.121	1.24189	2.597

a. Predictors: (Constant), IV 2
b. Dependent Variable: DV

ANOVA^a

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	13.058	1	13.058	8.467	.005^b
	Residual	81.742	53	1.542		
	Total	94.800	54			

a. Dependent Variable: DV
b. Predictors: (Constant), IV 2

Coefficients^a

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	10.065	.999		10.079	.000
	IV 2	-.710	.244	-.371	-2.910	.005

a. Dependent Variable: DV

(Source: IBM SPSS)

Table 7: Regression analysis for Hypothesis 3

Model Summary^b

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.014^a	.000	-.019	1.33728	2.055

a. Predictors: (Constant), IV 3
b. Dependent Variable: DV

ANOVA^a

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	.020	1	.020	.011	.917^b
	Residual	94.780	53	1.788		
	Total	94.800	54			

a. Dependent Variable: DV
b. Predictors: (Constant), IV 3

Coefficients^a

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	7.098	.997		7.118	.000
	IV 3	.024	.233	.014	.104	.917

a. Dependent Variable: DV

(Source: IBM SPSS)

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Table 8: Correlation test between different factors

		DV	IV1	IV 2	IV 4	IV 3
DV	Pearson Correlation	1	.321[*]	.371[**]	.290[*]	.014
	Sig. (2-tailed)		.017	.005	.032	.917
	N	55	55	55	55	55
IV1	Pearson Correlation	.321[*]	1	.229	.016	.357[**]
	Sig. (2-tailed)	.017		.092	.906	.007
	N	55	55	55	55	55
IV 2	Pearson Correlation	.371[**]	.229	1	.443[**]	.123
	Sig. (2-tailed)	.005	.092		.001	.369
	N	55	55	55	55	55
IV 4	Pearson Correlation	.290[*]	.016	.443[**]	1	.176
	Sig. (2-tailed)	.032	.906	.001		.198
	N	55	55	55	55	55
IV 3	Pearson Correlation	.014	.357[**]	.123	.176	1
	Sig. (2-tailed)	.917	.007	.369	.198	
	N	55	55	55	55	55

(Source: IBM SPSS)

Figure 1: Virtual Assets (Source: Školkay, 2020)
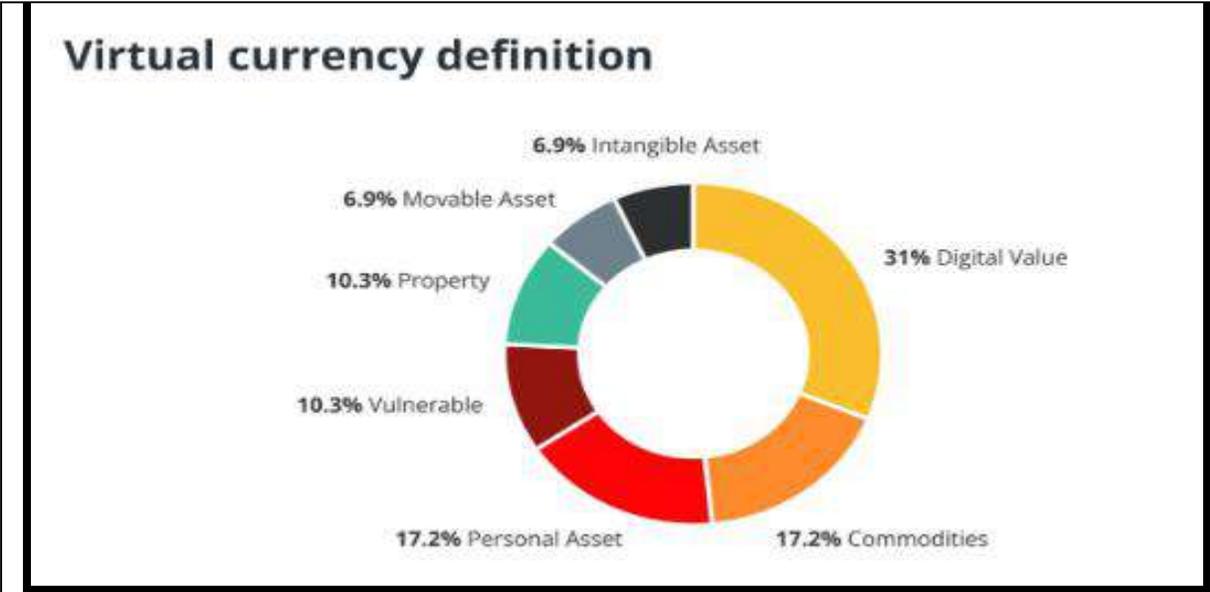
Figure 2: Virtual Currency (Source: Arab *et al.*, 2022)
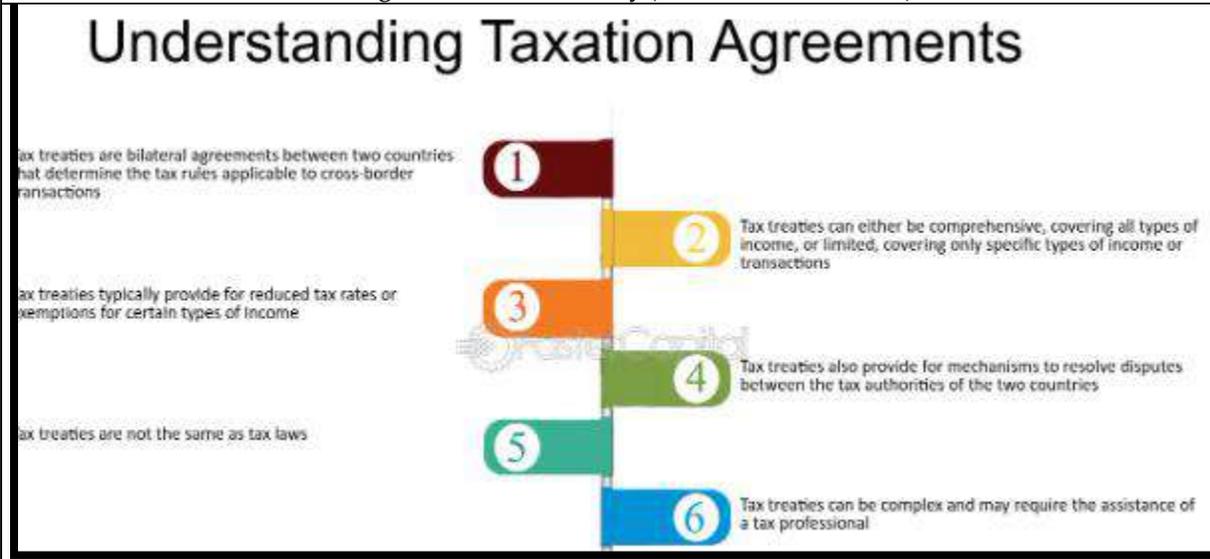
Figure 3: Taxation Agreements (Source: Robert *et al.*, 2023)

Figure 4: International Expansion Entry Modes (Source: Moncef & Monnet Dupuy, 2021)
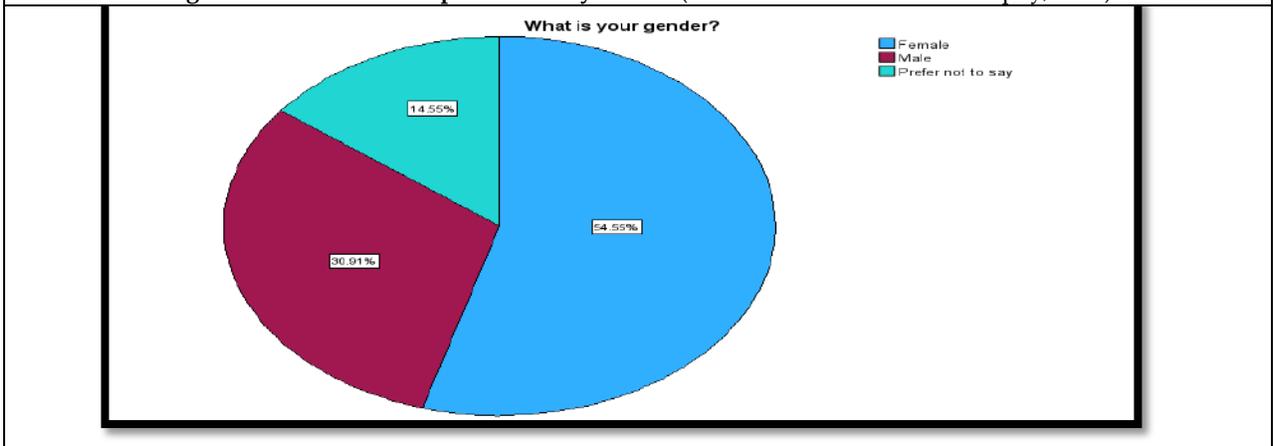
Figure 5: Gender (Source: IBM SPSS)
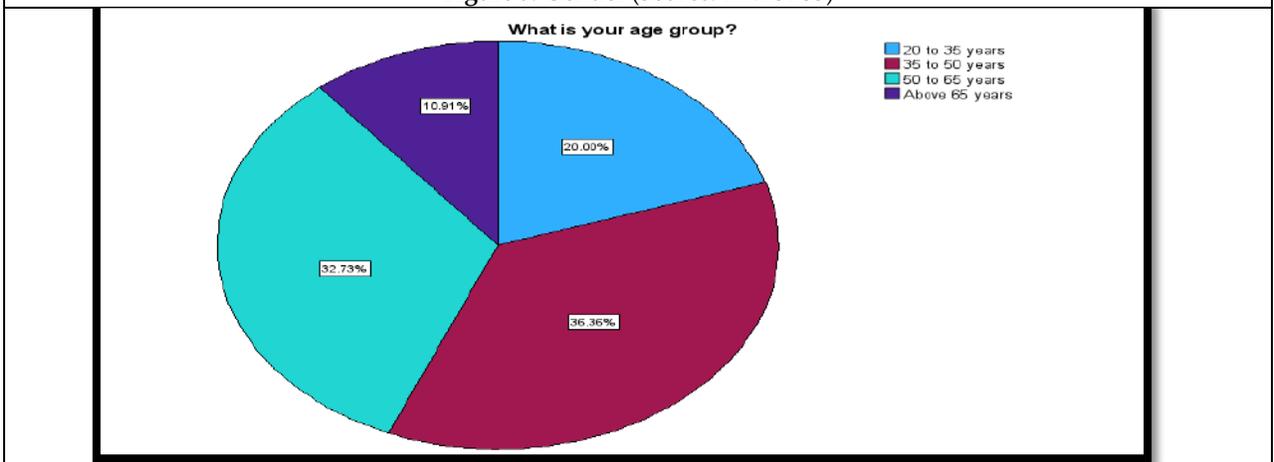
Figure 6: Age Group (Source: IBM SPSS)

RESEARCH ARTICLE

Measuring Return on Investment in Influencer Marketing

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ABSTRACT

Influencer marketing is an important marketing tool. This chapter provides insight into the aims of the research. Furthermore, the hypothesis is also developed in this chapter. The review of literature is given in this chapter analysing the overall theoretical framework of measures to analyse the performance of marketing. The matrix of inflation marketing is discussed in this chapter. Primary quantitative methods will be chosen to accumulate information on measures of influencer marketing. Moreover, the participant of the research is 55 and the Google form is selected to conduct a survey. The data has been analysed and interpreted using the IBM, SPSS software. Moreover, a graph and table are provided in this chapter for analysing outcome. This chapter consists of the overall discussion of the result of the research. Lead generation and the engagement rate are important metrics to analyse. Influencer marketing needs to choose the correct influencer who has a higher fanbase and power to depict and communicate the brand offerings effectively. A summary and snapshot of the overall research and findings are provided in this chapter. Influencer marketing importance as well as challenges is also analysed in the research.

Keywords: Influence marketing, social media, influencer, content creation, engagement rate, ROI.

INTRODUCTION

Influencer marketing has become highly utilised by companies to increase the awareness of the company in the dynamic competitive market. As technology has been revolutionised, the utilisation of social media platforms has been paramount. The company has used the social media platform to generate influencer marketing. According to Lal *et al*. (2020), The company has collaborated with social media influencers having major popularity on Instagram.

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This way the company has increased the appeal of their brand to the customer and also their product. However, measuring the return on investment (ROI) from influential marketing is necessary for analysing the impact of influential marketing on customers. Apart from this, measures can further help companies to make business decisions. The importance of measuring influencer marketing return is based on the influence of key performance indicators such as customer engagement, brand awareness and the sell encounter through influencer marketing. Developing a real relationship between the influencer and their potential followers becomes a major step toward the success of influencer marketing.

Influencer marketing is a kind of paid advertising which focuses on social media influence, creating awareness of products and services through their channels in the social media. The influential who have major popularity and fame in a specific industry has been chosen to influence marketing. For this purpose, the influencer has developed attractive content communicating the brand and its products and services to the audience. The likes and shares as well as engagement such as view clicks and impressions in that post have support to measure the performance of influencer marketing(Berne-Manero & Marzo-Navarro, 2020). Technology and advanced analytics tools play a major role in qualitative and quantifying aspects of influencer marketing, allowing businesses to interpret data and observe effective insights. Businesses have adopted influential marketing to generate leads and achieve sales. The customer highly trusted on the product or brand if referral by the people who mostly trust.

The above figure depicts the ways to measure the ROI in influencer marketing. Engagement, clicks, impressions, reach, audience alignment and product sales are the ways to measure the return on ROI. Moreover, the engagement rate shows a 90% result in encountering the impact of influencer marketing(Martínez-López *et al*. 2020). Furthermore, the clicks on the marketing give a 59% result in measuring the ROI in influencer marketing. Additionally, the impressions have provided a 55% impact on measuring the influencer marketing impact on the company. These metrics have played a significant role in tracking the performance. On the other hand, audience reach is also effective in gathering insight into the content frequency of viewers.

Aims
The main aim of the research is to measure the return on influencer marketing .

Objective
RO1: To examine the interconnectivity between content quality and ROI in influencer marketing
RO2: To analyse the relationship between generating leads and ROI in influencer marketing
RO3: To scrutinise the association between engagement rate on social media and ROI in influencer marketing
RO4: To evaluate the connection between targeting unique customers and ROI in influencer marketing

Research Question
RQ1: How does the content quality impact the ROI on influencer marketing?
RQ2: How lead generated leads to increase ROI on influencer marketing?
RQ3: How can the engagement rate in social media be increased using influencer marketing?
RQ 4: What is the impact of influencer marketing on targeting unique customers?

Hypothesis
H1: There has been a significant connotation between content quality and influencer marketing
H2: Generating leads has a positive connection with the ROI in influencer marketing
H 3: There is some distinct association between the engagement rate and ROI in influencing marketing
H 4: Targeting a unique audience is related to influencer marketing

LITERATURE REVIEW

Analyses the Role of Generating Leads in Measuring the ROI in Influencer Marketing

Lead generation on the post that has been run by influencers to showcase the brand and its service and product to customers helps to measure the ROI. The higher lead generated on the post represents a higher return from the influencer marketing campaign in social media(Silva *et al*. 2020). Furthermore, these show the performance of the campaign which is essential for analysing the return.

The above figure highlights the importance of lead generation in measuring the performance of influential marketing campaigns. For generating the lead, it is necessary to identify the correct influences and further develop effective connections with them. Additionally, establishing transparent expectations and goals is the third step to generating leads. Moreover, giving value to the audience of influence is integral for generating leads. In addition, it helps to measure and track the outcome of campaigns. Lead generation provided a tangible indicator of the influence of marketing campaigns. Influencers with their capacity to effectively interact with the audience, play an important role in greeting the brand awareness and driving the targeted audience. Furthermore, more effective collaboration with influencers has provided a powerful tool to analyse the performance of the campaign(Santiago *et al*. 2020). Unique discount quotes, action buttons and attractive content can help to generate leads and get a higher return from inflation marketing. Evaluating the conversion rate and the journey of customer development from influential marketing offers a transparent image of the effectiveness of a campaign.

Evaluating Unique Customer Target Roles in Increasing ROI in Influencer Marketing

Analysing unique customer targets gained from the marketing campaign can show the performance of the campaign. Influencer marketing has a major role in getting unique customers and targeting new audiences through the content of the campaign. Furthermore, the more audience targeted the higher the appeal of influencer marketing to the audience(Agustian *et al*. 2023). This helps to increase the sales of the company's product or service. As the main goal of influencer marketing is to target the customer, several customer targets indicate the effective result of the marketing campaign. However, influencer marketing is paramount to observe the interest and behaviour of the customer towards the product or service offered by the brand. The above Figures represent the impact of influencer marketing in social media. It has been identified that inflation marketing leads to developing trust and authenticity among potential customers. As stated by Tanwar *et al*. (2022), it is effective to reach the audience and create attractive content. Apart from this it develops social proof of the brand towards its customers and increases awareness. It is the most cost-effective way to generate leads and attract possible customers through the social media platform.

Critically Examine the Influencer Marketing Significance in the Engagement Rate of Audience in Social Media

Collaborating with the social media influencer can aid in developing online buzz about the company or brand. Additionally, it helps to strengthen the reputation and image of bread and also helps to boost the engagement of the audience by approving the conversion rate. As influencer marketing is effective in the proportion of services or products it also supports boosting the conversation rate of the marketing. According to Campbell & Farrell, (2020), Customers are more willing to buy products recommended by the people whom they trust or follow in their real lives. Hence, creating content marketing and communicating to its customers with the help of influencers can be effective. The engagement rate could be encountered through the likes and views in the content of the influencer.

Furthermore, the unique clicks and the share of the post design for the influencer marketing help to measure the performance and appeal of the marketing. The brand can effectively showcase its existing product and service as well as market its newly launched product and communicate its features to customers in a more effective way. The engagement rate can be increased by effectively targeting the potential audience of social media. Influence sir having a developed reputation and credibility has the power to mobilise and captivate these followers. Influencers developed codes that engage their followers and encounter their interest to vote in the marketing campaign(Kim & Han, 2020). Designing the content of the exposure marketing also plays a pivotal role in boosting customer

engagement. For maximising the influence of an inflation campaign, it is necessary to select the correct influencer which has the power to attract customers, develop effective corrections and design attractive content. Further, it is important to measure the success of a campaign to further decide on designing the campaign. Given figures depict the connection between authenticity and engagement rate in influencer marketing. Influencer marketing support to develop the trust of the audience. Further, it works as a social proof of the brand to its potential customers. Moreover, the attraction of the audience plays a pivotal role in the impact of influencer marketing.

Providing Suggestions to Improve the Content Quality to Boost the Appeal of Influencer Marketing
Influencer marketing can be amplified through collaborating with influencers who have higher credibility among the audience. Furthermore, designing the content that consists of the overall thing that is said to provide all the details and focusing on showcasing the benefits of the product or service is effective. Additionally, redirecting the audience is also effective and the landing page is also helpful to increase the result of the influencer marketing(Lou, & Yuan, 2020). Before designing content for marketing, it is effective to conduct market research and analyse the latest trends and demand in the market. Moreover, this helps to design the content which works better to attract customers and so the quality of the content can be improved in this way. Moreover, effectively selecting the audience and providing the major objective of the marketing is also integral for boosting the overall impact on the customers.

METHODOLOGY

Methodology can be defined as the procedure or technique that would be utilised in research to gather the details on the research topic. There have been two kinds of methodology which are secondary and primary. In this research, the "primary Quantitative method" has been chosen to assemble information on how ROI in influencer marketing can be measured. Quantitative research strategy is a method that aims at quantifying gathering and analysis of data. According to Hanif, (2020), Quantitative research is focused, fast, relatable and scientific. However, there has been some limitation of this method as well as it not providing theoretical insight into the research topic. The primary method consists of the focus group, interview and survey method. However, this research consists of an online survey to gather details. The primary method supports accumulating detail through the direct method and aids in answering the specific hypothesis of the research. Moreover, there has been numerical value included to show the outcome of the analysis which supports making the research more realistic and authentic. The questionnaire has been prepared including the 13 questions in which 3 questions ask demographic details of participants. Additionally, an online Google form has been given to participants for conducting surveys on measuring ROI in influencer marketing. The selected participant for this research is "55". On the other hand, IBM SPSS software will be used to interpret the assembled data. The IV and DV connection has been analysed using the SPSS tool by examining the descriptive statistics of the variables. SPSS has presented the outcome in the form of tables and graphs which provides easier insight into the result of the data interpretation(Lemenkova, 2019). Furthermore, regression analysis is also analysed using the SPSS. Additionally, the correlation coefficient is tested to show the connectivity between variables.

FINDINGS AND RESULT

Gender
The above table highlights the participant gender in the survey. The frequency of female participants in the survey is 19. The highest number in the research is male and their number is 30. However, 6 participants in the research preferred not to say their gender. The above graph provides the gender snapshot of participants. The female participant in the research is 34.55%. Furthermore, the male participant in the research is 54.55%. However, 10.91% of participants do not disclose their gender. This means that the male gender has highly participated in presenting a perspective on ROI in influence marketing. The female also takes part in the research. This survey has provided equal opportunity to both genders and supported to neglect of gender biasness.

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Age

Given table highlights the frequency of age of responders. It has been observed in the table that, highest number of participants belongs to the 35-to-44-year age group. Furthermore, the second highest frequency participant has an age between 24 to 34. Moreover, the frequency of 18-to-24-year age groups is 12. This indicates that more than 18 people are supported to take part in the research. Age percentage analysis has been observed with the help of the above Pie chart. The highest number of participants who belong from 25 to 34 years is 43.64%. However, the 35-44-year participants contributed to 34.55% in research. Moreover, the participant age group between 18-24 per cent stood at 21.82%. This result shows that a 25–34-year group individual is efficient enough to answer the question of research.

Income Level

The given table explores the income level of respondents. It has been observed that the highest number of participants have an earning capacity of 31000-40000. However, the least participants belong from more than 40000. The participants whose earning capacity is 21000-30000 frequency in research are 13 and 12. The number of participants who have monthly earnings is 15000-20000. This depicts that all income group people are engaged in the survey to explore their perspectives. The above pie graph aids in exploring the income level analysis in percentage form. It has been observed in the graph that 43.64% is the highest which stood for the 31000-40000 earning participant. Besides this, the participant whose monthly income level is 15000-20000 was observed as 10.91% in the research study.

Descriptive Statistics

The above table explores the descriptive statistics of the IV and DV of research. It has been observed that the mean value of DV is 6.63 the skewness is 0.6 and negative 0.5 is the kurtosis. Descriptive statistics offer insight into the central tendency, data frequency and distribution. Furthermore, the mean value for IV to Iv 4 is 5.67,6.00,6.32 and 7.07 respectively. Correlation coefficient utilises to present direction and strength of linear connectivity of variables. However, the skewness Statistics values of IV1 to Iv4 are 0.37,0.15,-185 and 0.38 respectively. On the other hand, the value of kurtosis is -0.94,1.23,1.26 and 1.25 for IV1 to IV4 respectively. The ideal kurtosis values are between -2 to +2 and all the dependable and independent variables are ideal. So, the hypothesis is acceptable.

Hypothesis

H1

The above table propounds the first hypothesis. The R and R Square of IV1 are observed as 0.34 and 0.10. Furthermore, the F change is 7.240 and the Durbin waston stood at 1.681. Besides this, the significance value is 0.10. A significance value of more than 0.5 is acceptable. Therefore, content quality and ROI in influencer marketing have been positively connected.

H2

The above table explores the testing of hypothesis 2. The R change of IV2 is observed as 0.40 and the Durbin Waston is 2.083. The acceptable range of Durbin Watson is 1.50 to 2.50. Therefore, this value suggests that the hypothesis is accepted. The F value is 2.22 and the significance value is 0.14. Hence, lead generation is significantly related to the ROI in influencer marketing.

H3

Hypothesis third can be analysed using the above table. The R square change is 0.30 and the significance F change is 0.000. Furthermore, Durbin waston is encountered as 2.080. The F value stood at 23.13 and the significance value was 0.000(Uyanto, 2020). Hence, the null hypothesis is rejected in this case and the alternative hypothesis is accepted. Engagement rate is vital for measuring the ROI in influencer marketing. There has been interconnectivity between the engagement rate and ROI in influencer marketing. This table aims to examine the connectivity between the targeting of new customers and ROI on influencer marketing. The r square change of IV4 is 33.688. Moreover, the Durbin waston is 2.79 which is more than the ideal value. Hence, the alternative hypothesis is suitable in this case

and rejects the null hypothesis. The significance value is 0.000 which indicates the positive connection of targeting unique customers with measuring influencer marketing ROI. Targeting unique customer share connectivity with measuring the ROI in influencer marketing.

Correlations
This table focuses on testing the correlation between the DV and IV. The Pearson correlation of DV is 1 and -0.38,0.201,0.552 and -0.623 respectively for IV 1 to Iv 4. Furthermore, IV 1 which is content quality is related to the engagement rate, lead generation as well return on influence marketing. The value between positive and negative 1 showcases the effective correlation among the variables. It can be said after analysis table DV is interconnected with all IVs and each IV is related to each other.

DISCUSSION

Conversion rate, engagement rate, and the lead generated through the influencer marketing campaign have effectively supported measuring the ROI in influencer marketing. Using the social media platform brands can run the influencer marketing campaign and observe the performance through the lead generated and the engagement in the post. Apart from this the cell achieved through inflation marketing can also work as a measurement and indicated tool for influencer marketing. According to Arora *et al*. (2019), clicks on the post and the unique leads generated through the campaign are also KPIs for measuring the performance of a campaign. Furthermore, more than fresher marketing is important to boost brand awareness, engagement and trust among potential customers. Qualitative measurement is also utilised for basic impact marketing. The brush is required to develop attractive content that correlates with the audience on a personal level and binds them to purchase the product. The requirements and needs of the customer are also required to be analysed before developing and designing the content for the social media campaigns. It has also been supported to foster the brand reputation and showcase the product and features of the brand.

The content run in the social media has provided insight into the performance which consists of the uniwireless and views on the post. This helps the company to identify whether the influence marketing provides the desirable outcome or not. Moreover, designing the content by taking the face of the influencer and running ads on Instagram would be effective in driving sales(Mallipeddi *et al*. 2022). The higher the targeted audience through the campaign it represents the higher the performance of the influence and marketing. However, it is also important to analyse the per-targeted customer cost in influencer marketing. The brand needs to analyse the overall cost that goes to develop and run the campaign such as agency fees, influence fees, ad spend and production costs. Thereafter, it is required to evaluate the total sales drive and profit made through the marketing. The reaction to the post and new customer reach is also another way to track the performance. However, there have been many challenges faced while conducting influence marketing(Krizanova *et al*. 2019). These challenges are selected by the right ones who have the potential to impact the customer about the brand. Further, the other challenges are correct with the designing of the content for the marketing. Among all that measuring the ROI in influencer marketing is also a very challenging and complex process.

CONCLUSION

In conclusion, influencer marketing has become more used by the company as their marketing strategy. However, it is difficult to measure the ROI from the campaign. The social media platform such as strograp at Facebook has been predominantly used by the breast to run ads and target the potential audience. This takes higher investment as well, it is also more profitable from marketing. Nowadays, customers are highly engaged in social media, so it is an effective platform to interact with customers and analyse their purchase behaviour. Moreover, the fees of the influence depend on the following they have on social media channels. It also develops the online presence of the brand and provides a platform to know the interests of the customer. However, customers can visit the page of the

brand as well as sell the products using the social media platform. In addition, engagement rate, lead generation and issue sales are the metrics to track the performance and analyse whether the desirable motive of influencer marketing is achieved or not. Influencer marketing has provided a higher advantage to companies to generate trust among customers. Furthermore, investing in influencer marketing provides more ROI by driving sales and fostering the engament.

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Appendices
Appendix
1:Questionnaire:
[Survey Link:https://docs.google.com/forms/d/1z7dCPYvYITrh6FNl5QbHSVIFmTNf4gAV82MgTJCQKOQ/edit]
Q1. What is your gender
Male
Female
I prefer not to say
Q2: What is your age
18-24
25-34
35-44
45 and above
Q3: What is your income
15000-20000
21000-30000
31000-40000
More than 40000
Dv: Influencer Marketing
4. Influner marketing generates huge revenue by bringing the sales
5. Influencer marketing helps to create brand awareness among customer
IV1: Content Quality
6. Content quality has a great impact on influencer marketing
7. Higher content quality can lead to attracting more customers towards marketing
IV 2: Generating leads
8. Creating content material and resources that offer value to customers can generate leads

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9. Identifying influencers who resonate with the audience and brand is effective for generating leads through influencer marketing

IV 3: Engagement rate

10. Influencer marketing can aid in increasing the customer engagement rate

11. A higher engagement rate indicates the audience of influence is interested in content

IV 4: Targeting Unique Customers

12. Influencer marketing has been effective in targeting unique customer

13. Influencer marketing has developed to identify the interest of customers and target unique customer

Strongly Disagree

Disagree

Neutral

Strongly Agree

Agree

Table 1: Gender Analysis (Source: SPSS)

Q1. What is your gender

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Female	19	34.5	34.5	34.5
	Male	30	54.5	54.5	89.1
	Prefer not to say	6	10.9	10.9	100.0
	Total	55	100.0	100.0	

Table 2: Age Analysis (Source: SPSS)

Q2: What is your age

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	18-24	12	21.8	21.8	21.8
	25-34	24	43.6	43.6	65.5
	35-44	19	34.5	34.5	100.0
	Total	55	100.0	100.0	

Table 3: Income level (Source: SPSS)

Q3: What is your income

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	15000-20000	12	21.8	21.8	21.8
	21000-30000	13	23.6	23.6	45.5
	31000-40000	24	43.6	43.6	89.1
	More than 40000	6	10.9	10.9	100.0
	Total	55	100.0	100.0	

Table 4: Descriptive Statistics (Source: SPSS)

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
DV	55	5.00	9.00	6.6364	1.07778	.692	.322	.520	.634
IV1	55	3.00	9.00	5.6727	2.10866	.376	.322	-.943	.634
IV2	55	3.00	9.00	6.0000	2.05480	.159	.322	-1.238	.634
IV3	55	3.00	9.00	6.3273	2.26122	-.185	.322	-1.267	.634
IV4	55	3.00	10.00	7.0727	2.30020	-.386	.322	-1.258	.634
Valid N (listwise)	55								

Table 5: Hypothesis 1 (Source: SPSS)

Model Summary^b

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	F Change	df1	df2	Sig. F Change	Durbin-Watson
1	.347^a	.120	.104	1.02044	.120	7.240	1	53	.010	1.681

a. Predictors: (Constant), IV1
b. Dependent Variable: DV

ANOVA^a

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	7.539	1	7.539	7.240	.010^b
	Residual	55.189	53	1.041		
	Total	62.727	54			

a. Dependent Variable: DV
b. Predictors: (Constant), IV1

Coefficients^a

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	7.642	.398		19.195	.000
	IV1	-.177	.066	-.347	-2.691	.010

a. Dependent Variable: DV

Table 6: Hypothesis 2 (Source: SPSS)

Model Summary^b

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	F Change	df1	df2	Sig. F Change	Durbin-Watson
1	.201^a	.040	.022	1.06577	.040	2.224	1	53	.142	2.083

a. Predictors: (Constant), IV2
b. Dependent Variable: DV

ANOVA^a

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	2.526	1	2.526	2.224	.142^b
	Residual	60.201	53	1.136		
	Total	62.727	54			

a. Dependent Variable: DV
b. Predictors: (Constant), IV2

Coefficients^a

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	6.005	.447		13.427	.000
	IV2	.105	.071	.201	1.491	.142

a. Dependent Variable: DV

Table 7: Hypothesis 3 (Source: SPSS)

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
1	.551[a]	.304	.291	.90769	.304	23.135	1	53	.000	2.080

a. Predictors: (Constant), IV3
b. Dependent Variable: DV

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	19.061	1	19.061	23.135	.000[b]
	Residual	43.667	53	.824		
	Total	62.727	54			

a. Dependent Variable: DV
b. Predictors: (Constant), IV3

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	4.974	.367		13.565	.000
	IV3	.263	.055	.551	4.810	.000

Table 8: Hypothesis 4 (Source: SPSS)

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
1	.623[a]	.389	.377	.85064	.389	33.688	1	53	.000	2.797

a. Predictors: (Constant), IV4
b. Dependent Variable: DV

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	24.377	1	24.377	33.688	.000[b]
	Residual	38.351	53	.724		
	Total	62.727	54			

a. Dependent Variable: DV
b. Predictors: (Constant), IV4

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	4.570	.374		12.222	.000
	IV4	.292	.050	.623	5.804	.000

a. Dependent Variable: DV

Table 9: Correlation analyis (Source: SPSS)

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Correlations

		DV	IV1	IV2	IV3	IV4
DV	Pearson Correlation	1	-.347**	.201	.551**	.623**
	Sig. (2-tailed)		.010	.142	.000	.000
	N	55	55	55	55	55
IV1	Pearson Correlation	-.347**	1	-.231	.303*	.097
	Sig. (2-tailed)	.010		.090	.025	.483
	N	55	55	55	55	55
IV2	Pearson Correlation	.201	-.231	1	.024	.282*
	Sig. (2-tailed)	.142	.090		.862	.037
	N	55	55	55	55	55
IV3	Pearson Correlation	.551**	.303*	.024	1	.551**
	Sig. (2-tailed)	.000	.025	.862		.000
	N	55	55	55	55	55
IV4	Pearson Correlation	.623**	.097	.282*	.551**	1
	Sig. (2-tailed)	.000	.483	.037	.000	
	N	55	55	55	55	55

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).
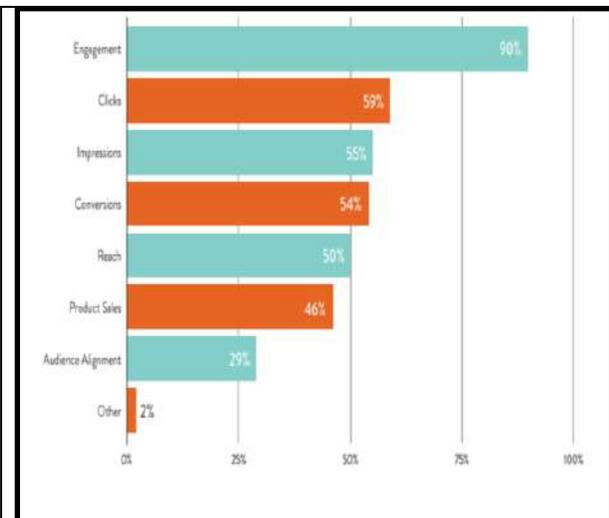
Figure 1: Metrics for measuring the Influencer marketing ROI (Source: Martínez-López *et al*.2020)

Figure 2: Ways to lead generation collaborating with an influencer (Source: Santiago *et al*.2020)

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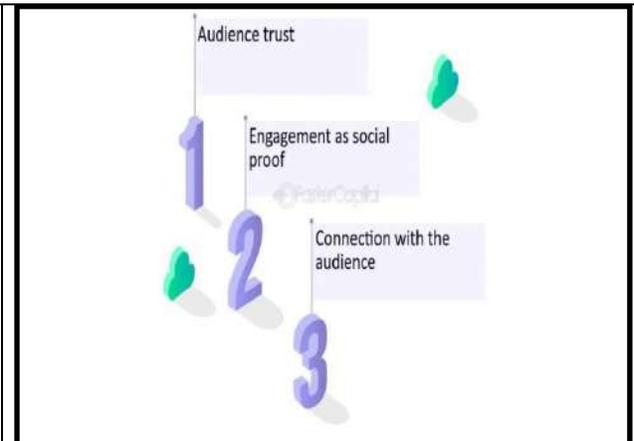
Figure 3: Power of Influencer marketing (Source Tanwar *et al*.2020)

Figure 4: Connection between engagement rate and Influencer marketing (Source Tanwar *et al*.2020)
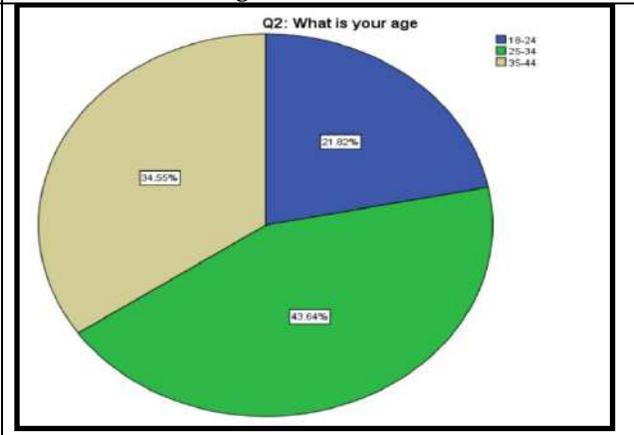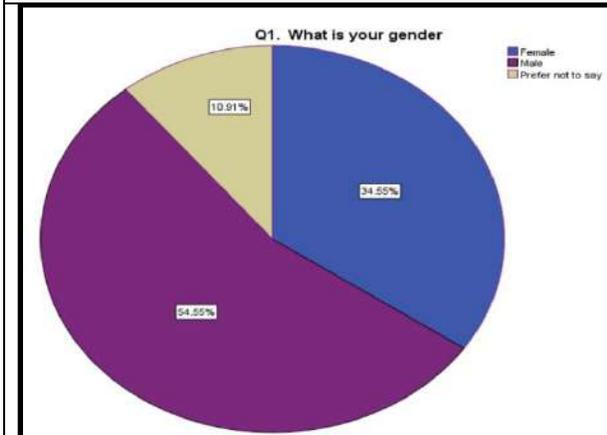
Figure 4:Gender (Source: SPSS)

Figure 5: Age analysis (Source: SPSS)
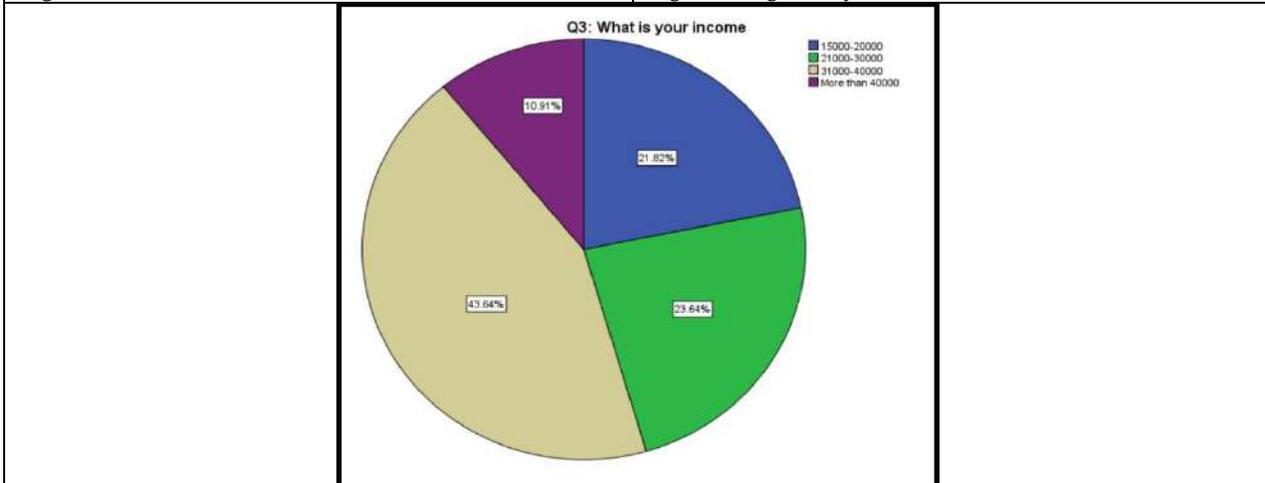
Figure 6:Income level (Source: SPSS)

REVIEW ARTICLE

Corporate Social Responsibility: Marketing Strategy or Ethical Obligations

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ABSTRACT

This part consists of the overall introduction of CSR activities and analysis of whether it is ethical obligations or marketing strategy. Furthermore, this chapter consists of the research aims and objectives. Additionally, research questions and hypothesis has been developed in this chapter. This chapter encompasses the discussion on the CSR initiatives and overall benefits and challenges of CSR. This chapter provides the methodology of research that would follow to assemble informal CSR activities. The primary quantitative method has been followed in the research study. The online survey using the Google form is conducted. The participants in this research are 55. Furthermore, to interpret the gathered data SPSS software was employed. The data that has been collected has been analysed using IBM,SPSS tool. Descriptive statistics, regression analysis, and the correlation test have been analysed to identify the outcome. This chapter analyses the findings of the study. Moreover, a discussion on CSR activities has been presented in the chapter. The overall summary of the whole research is provided in this chapter's initiatives have become adopted by many companies as their marketing strategy to increase awareness or as ethical obligations.

**Keywords:** Corporate social responsibility, green branding, fair trade practises, social responsibility.

INTRODUCTION

Corporate Social Responsibility (CSR) has become an important element of business activity. Nowadays consumers are highly conscious of the influence of their choices, forms are compelling to navigate the effective balance between society's well-being and profit maximization. Marketing social responsibility is the procedure of attracting customers

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by utilizing ethical business practices and supporting major social causes. As stated by Carroll, (2021), Developing a social responsibility campaign utilizing customer data such as their belief, values, and personality traits. CSR activity in business consists of focusing on efforts to get the attention of more customers who want to develop a positive variance between their purchases CSR is also an effective marketing strategy with cons are green branding, and exploring the utilization of eco-friendly materials in the business. Ethical obligations in business include ensuring a firm is connected in fair practices of business across the board. Companies are required to treat all the stakeholders of the company such as customers, employees, and other stakeholders more ethically. Business ethics is likely to aim at marketing or individual group decisions. There has been much criticism regarding CSR as it is considered nothing more than a marketing strategy implemented by a corporation to boost its brand reputation and achieve a competitive market(Tamvada,2020). The major behind such initiatives is frequently seen as a profit maximization tool focusing on amplifying the breadth of image and enhancing customer loyalty. The social responsibility concept in business highlights that business balances their operation of money-making activities that advantage the society, be it on a national, local nad international scale. Various companies have adopted socially responsible components in their strategy of marketing through beneficial products and services.

The above figure represents how CSR activities help to develop effective customer support. CSR helps to buy products for about 91.4% of customers. However, it gives the benefit of the doubt to 84.3%. The rate of buying products from the company, and maintaining the CSR initiatives is high. Ethical behaviour, accountability, transparency, respect for human rights, stakeholder interest, and the rule of law are the major principles of CSR. According to Tien et al. (2020), Most of the business data shows that customers choose to do business with companies that perform ethically. By implementing social marketing, a firm can represent consumers and fulfil the social demands of the customers. It can support the companies to achieve higher market share by developing it more attractive as compared with the competitors using different marketing methods.

Aims
The main aim of the research is to analyse the corporate Social Responsibility is a marketing strategy or an ethical obligation.

Objective
RO1: To analyse the connection between fair trade practices and CSR
RO2: To evaluate the connection between equal pay and CSR activity
RO3: To scrutinise the association between green branding and CSR
RO4: To examine the relation between equal treatment to each stakeholder and CSR

Research Question
RQ1: How do fair trade practices impact the CSR initiative of business?
RQ2: How does equal pay is connected with the CSR activity in business
RQ3: How does green branding impact the CSR initiative?
RQ4: How do CSR and equal treatment to every stakeholder relate

Hypothesis
H1: Fair trade practices and CSR share a positive interconnection
H2: There is an association between CSR and equal pay
H3: There is interconnectivity between the CSR and the green branding
H4: There is a significant connection between equal treatment to each stakeholder and CSR

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LITERATURE REVIEW

Analyse the Corporate Social Responsibilities and ethical obligations in business
CSR is a business approach by which companies can develop concerted efforts to run with that boost rather than degrade the environment and societies can support and boost many aspects of society and encourage a positive brand reputation for companies. Companies that prefer the CSR method have frequently grown their business to the level where they can provide back to society(Dmytriyev et al. 20210. Thus, CSR is mainly a strategy that is adopted by large companies. After successfully implementing this strategy, there has been much responsibility needed to set standards of ethical manners for its competitors and industry.

Green branding
Green bending refers to the practice of advertising and developing products based on perceived or real environmental sustainability. An example of green marketing consists of advertising the product which shows decreased emissions connected with product manufacturing procedure or utilisation of post-consumer recycled material for packaging of products(Ferrell et al. 2019). Green branding is an important CSR practice which represents the commitment to a company to using environmentally friendly methods and products in the manufacturing process. This practice helps to reduce the negative impact on the environment and make the business more sustainable.

Fairtrade practises
Fair trade practices are also CSR activity by preferring equitable and ethical business norms. Companies connected to fair trade are committed to making sure that their products are highly produced and sourced under human conditions with fair respect, rights and wages to all employees. This encompasses accountability at transparency within the share of supply, actively working to reduce wastage and encourage economic empowerment in society(Zou et al. 2021). By following fair trade practices, companies can support environmentally friendly trade practices, responding to societal issues.

Equal treatment for all stakeholders
CSR also ensures equal treatment to every stakeholder by corporation classic and ethical practices across different business activities. This refers to fair wages, fostering diversity and managing and shaping work culture(Beji et al. 20210. Customer relations aims at transparent communication and fair pricing for the quality delivery of services or products. However, investors are treated equally by providing transparent financial disclosure to each other. By contributing to equal treatment, companies can develop trust, contribute to community welfare, gain growth opportunities and ensure the sustainability of business

Evaluating the benefits of CSR activities in business
As vital as CSR is for the community, it is similarly valuable for the organisation's initiatives can support the development of a connection between the corporation and employees, increase morale and help both employers and employees feel more associated with the world around them. Aside from the positive influence on the environment, below are some other advantages of CSR to business:
The above figure highlights some benefits of CSR to the business. The benefits of CSR consist of attracting more customers, boosting the customer retention rate, and brand recognition, boosting the influence on the industry and helping to get more funding opportunities. Some of these have been discussed below:

Stakeholder relation
As per the published study in the Journal of Consumer Psychology, customers are more likely to behave favourably towards a form that has maintained CSR initiatives. Customers are becoming more aware of the influence of business on society and the community(Ashrafi et al. 2020).CSR initiative supports the development of positive connections with the holders whether it is investors, customers or employees, representing a commitment to

environmental and social responsibility by encouraging a sense of shared value. Motivated and engaged employees contribute to more productivity while satisfying customers is the major responsibility of the company. Companies are also required to satisfy the investor and the investor considers CSR an effective business management strategy, decreasing some business risk and possibly retaining ethical investment.

Brand Recognition
CSR has a major role in making the image of the company positive. Connecting in socially responsible activities represents a commitment to ethical practices of business and society welfare(Koch et al. 2019). Customers highly prefer and value companies that are connected with social responsibility. This further helps to increase brand recognition in the industry and leads to boosting customer trust and loyalty.

Employee Engagement
CSR activity has supported to increase in the employee's engagement rate. When the employee encounters that their company is highly engaged in the environment and society, it develops a positive work environment leading to improved productivity and morale. Furthermore, this helps to decrease employee turnover, and total cost of attending employees and increases customer engagement which leads to improving the business outcome.

Risk Mitigation
CSR is important for mitigating the risk within the business. Connecting in social responsibility activities and company to mitigate the potential regulatory, reputational and legal risk associated with business. By actively mitigating social and environmental issues, businesses highlight responsible management and decrease the chances of facing legal concerns or damaging the company's reputation(Belas et al. 2021). This risk-aware method can provide a competitive advantage and businesses can survive in a dynamic competitive market in the long run.

Critically analysing the challenges faced while implementing CSR initiative
There have been challenges irrigated while waiting for the CSR in the business. These challenges are discussed below:

Resource allocation
The major concern while implementing the CSR is the resource allocation. Balancing the human and financial resources needed for CSR activities is an important business operation and can be more challenging.

Demand for disclosure and transparency
Stakeholders of every kind from suppliers to consumers to team members, local community and investors are highly demanding more accountability and transparency from firms with whom they pursue business(Kumar, 2019). Business requires practices that prefer an effective way to assemble, organise, manage and analyse their data for accurate, complete and clear reporting of business activities and finance.

Differing priorities and corporate culture
The company needs to provide a United Front with contes to business ethics and its impact on environmental, social and political concerns. However, companies can face challenges in getting everyone into the same frame, mainly when different units of business have diverse goals and priorities that might be connected with corporate objectives for the bottom line, but not highly in CSR activities.

METHODOLOGY

Research methodology is the process of explaining how the research is carried forward. It describes the method and procedure for the data collection and analysis. This research has utilised the "Primary Quantitative"method for the data collection about corporate social responsibility. This method will support the collection of direct information on

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CSR practices in business rather than focusing on past research data. Moreover, this method takes care of our effective insight and accurate data on the CSR and ethical obligations of business. In contrast, there have been many limitations to using this research method. This method consumes more time and data interpretation is limited(Puspitarini, &Hanif, 2019). Personal knowledge and experience impact the observation and conclusion of the research. There have been many ways to collect information such as interviews, direct observation, focus group surveys and questionnaires. However, in this study "Survey and Questionnaires' ' has been employed to accumulate data.

Firstly, a total number of 13 questions has been prepared of which 3 questions related to the demographic of the participant and the other 10 questions on the factors influencing the CSR. The "online Google form" has been used in this research to conduct a survey. Further for analysing the data ``IBM SPSS '' software has been used. The selected sample size for the research is 55. On the other hand, DV and IV are selected to effectively present insight into CSR. Moreover, descriptive statistics and correlation analyses of the Iv and DV will be analysed using SPSS software. Apart from this, regression analysis to test the hypothesis is done in this research. SPSS software provides reliable and accurate answers to the data collected. Furthermore, it used graphs and tables which provide the appropriate insight into the result of the findings. Quantitative methods provide the results that are more reliable and accurate as well as the numerical values(Braun et al. 2021). The SPSS helps to interpret the assembled data and support the discussion of the hypothesis of the research.

FINDINGS AND ANALYSIS

Demographic Analysis
Gender
The above table consists of the gender frequency of the participants. It has been observed in the table that the frequency of females is 9 and the male frequency is 19. However, the major participant head chose not to disclose their identity in the research. The gender-bias has been neglected in the research and also provides the option to make gender confidential. The analyses of gender in percentage form can be analysed using this graph. The graph shows that 45% of participants prefer not to say gender. Furthermore, 15% of participants are female and the highest number of participants are male with a percentage of 31.67%.

Age Group
The above pie chart represents the percentage of the age analysis in a survey. The highest number of participants who belong from 18 to 25 years and more than 45 per cent of students are 30%. Moreover, the percentage of 36–45-year participants in research is 15%- and 26-35-years accounts for 16.67%. Table 3 propounds the designation analysis in the research. This research mainly consists of the participants who are associated with business and their role in CSR is paramount. There have been 19 participants in the survey who are 19 among 55 participants. Furthermore, 28 participants are employers and 9 each are shareholders and board of directors who are mainly engaged with business activities. The pie graph highlights the designation percentage. The highest number of participants are customers, their contribution to research is 31.67%. Moreover, the employer's participants in the survey are 30%. Additionally, there have been 15% participants who are BOD and shareholders.

Statistical Analysis
Descriptive statics
The given table consists of the descriptive Statistics of the IV and DV. Minimum and Maximum Statistics of DV which is CSR encountered as 3 and 10 respectively. Furthermore, SD is 2.57, skewness is negative 0.325 and kurtosis is observed as 0.634. Additionally, the minimum and maximum Statics of IV 1 which is fair trade practises are 8 and 5.82 corresponding. Besides this, skewness and kurtosis values are observed as 0.5 and negative 1.43. Moreover, IV 2 which is equal pay mean value is 6.499 and the negative 0.251 is skewness. Furthermore, the mean value of Iv 3 which is green branding is 6.89 and Iv 4 which represents equal treatment to every stakeholder observed as 7.18.

Hypothesis 1

The above table presents hypothesis 1 in which IV1 is fair trade practice connection with CSR which DV has analysed. The df of regression is 1 and the mean square is 4.84. The F value is observed as 20.763 and the significance value is 0.000 which is less than 0.5. The t value of the hypothesis encounter is 10.325 which is more than 2, it indicates a positive connection of DV with IV1. There has been a significant relationship between the fair-trade practices and the CSR.

Hypothesis 2

The provided table analyses hypothesis 2 which shows the connectivity between the DV and IV 2.The R and R square encounter as 0.62 and 0.39. The Durbin Watson value is 3.52, as it is more than 2 this indicates the autocorrelation between DV and IV2. The beta value of IV 2 is 0.625. The significance value of the IV2 is observed as 0.34 which is less than 0.5, it indicates a positive relationship. There has been a positive connection between equal pay and CSR.

Hypothesis 3

The above table indicates hypothesis 3, which is green branding connection with the CSR. The f value is 0.02 and the significance value is 9.79 in research. Furthermore, the beta value of IV3 is negative 0.04 and the t-value is 6.76. Therefore, green branding is correlated with the CSR initiative.

Hypothesis 4

This table shows hypothesis 4 and identifies the connection between IV4 which consists of equal treatment to every stakeholder and DV. Moreover, the F value is 21.43 and the significance value is 0.00. The t value of IV4 is 8.36. This represents IV4 the interconnectivity with DV. The R and R square of the variable has been observed as 0.5 and 0.2 respectively. Equal treatment of stakeholders is related to the CSR.

Correlation Analysis

The above table consists of the correlation analysis of the IV and DV. The IV1, IV2 and IV3 are less than 0.5 which represents the connectivity with DV and Iv3 and is more than 0.05, which explores negative connectivity. On the other hand, while identifying the connectivity of IV1 with other IVs and DV it was observed that DV is 0.000. Furthermore, all other IVs are significant that propound the IV1 is significantly related to DV and the remaining IV. Additionally, DV and IV are 0.97 and 0.76 which propound effective connection. Hence, the above analysis, represents that fair trade practices, equal pay, green branding and treating all stakeholders equally are highly correlated with corporate social responsibility.

DISCUSSION

CSR has become important for surviving in a highly competitive business environment. It becomes a marketing strategy as well as an ethical obligation of the companies to maintain CSR in business. While making the business profitable it is mandated to ensure social responsibility is the biggest word in society. According to Zaman et al. (2022), This increase in the market pages creates a positive blood image in front of consumers and consumers are more likely to connect and purchase products of companies who follow ethical obligations. While talking about CSR as a marketing effort, it highly contributes to creating awareness and boosting the reputation of the company as well as appealing to the community. By making the business more sustainable and offering charity to society, companies can differentiate the brand in the highly competitive market and gain the customer's trust. In this context, following fair trade practices is crucial. Fairtrade practises design standards and codes of conduct that mainly come to the resilience of sustainable production, compliance and good quality products at reasonable prices(Okafor et al. 2023). On the other hand, the company is also required to follow equal pay for each employee working in a company and treating the same is also an effective way to improve the appeal of CSR initiatives in business. However, it developed a sense of motivation among employees which is necessary for improving CSR initiatives.

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Apart from this, encouraging products and services which are environmentally friendly is effective green marketing that increases the appeal of the CSR initiative of business. As per Mahmud & Fekete-Farkas, (2020), The businesses that adopt eco-friendly procedures as well as materials in the function and production of business have contributed to CSR. Moreover, recycled products and eco-friendly packaging are also included in green branding to maintain social responsibility. Treating all the stakeholders of a company is an important step in CSR undertaking for business. The business requires two considered ethical obligations and reduces the biases among employees. Making sure good trade practices is an important ethical obligation and providing accountability and transparency of overall operation followed in the company is also necessary to aid companies in connecting with their stakeholder consisting of employees, customers, communities and suppliers. This developed a sense of loyalty and trust, which is vital for the business to survive in a competitive market in the long run.

CONCLUSION

In conclusion, CSR is also an ethical obligation as well as marketing strategies which have been adopted by the companies to increase their image in the market. Many of the critics have said that CSR activity is adopted by companies as a marketing strategy and its major purpose is to make the business more profitable. However, it has been also seen as an ethical obligation which needs to be followed the help the business develop a unique Identity and make the business different from its competitors has many benefits as well it consists of several challenges when adopting this strategy by the companies. It is seen as a major marketing strategy that supports companies to amplify the appeal of a brand to its customers social responsibility and ethics are used interchangeably, there is vast variance between these two terms. Ethics are mainly focused on marketing or individual group decisions, while social responsibility is regarded as the wholesome effect of marketing activities on society. The success of brands has been based on effectively managing the valence between real ethical commitment and strategic marketing. Nowadays, customers become more concerned about the impact of business activities on the environment. Hence, adhering to eco-friendly measures in business function delight customers and attract them to purchase the product.

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Appendices
Appendix1: Questionnaire
[Surveylink:https://docs.google.com/forms/d/1cp1HbSFaWhqEkZcokYwKv_001zO6jmS8rCix-b7l20s/edit]
1. What is your age
18-25
26-35
36-45
More than 45
2. What is your gender
Male
Female
I prefer not to say
3. what is your designation
Employee
Board of director
Customer
Shareholder
DV: Corporate Social Responsibility(CSR)
4. Corporate social responsibility(CSR) is also a responsible marketing strategy for business.
5. Companies can develop social CSR cabbage using data from customers
IV1: Fair Trade Practises
6. Fair trade practices are necessary for maintaining CSR in business
7. Fair Trade practices can boost the result of effective marketing campaigns of CSR
IV2: Equal Pay
8. Equal pay is legally mandated by the government as a CSR practice in business
9. Paying equal wages and treating all employees equally is an effective CSR practice
IV3: Green branding
10. Companies can improve green branding practices by associated in adopting eco-friendly products
11. Green branding is also an important CSR practices and implore the appeal of marketing strategy
IV4: Fair treatment to every stakeholder
12. Fair treatment to all stakeholders including employees and customers is vital CSR in business
13. Ensuring the equal treatment to each stakeholder is prominent CSR activities
Strongly Disagree
Disagree
Neutral
Strongly Agree
Agree

Table 1: Gender analysis

2. What is your gender				
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid					
	Female	9	15.0	15.0	23.3
	I prefer not to say	27	45.0	45.0	68.3
	Male	19	31.7	31.7	100.0
	Total	55	100.0	100.0	

(Source: SPSS)

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Table 2: Age analysis

1. What is your age

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid				
18-25	18	30.0	30.0	38.3
26-35	10	16.7	16.7	55.0
36-45	9	15.0	15.0	70.0
More than 45	18	30.0	30.0	100.0
Total	55	100.0	100.0	

(Source: SPSS)

Table 3: Designation analysis

3. what is your designation

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid				
Board of director	9	15.0	15.0	23.3
Customer	19	31.7	31.7	55.0
Employer	18	30.0	30.0	85.0
Shareholder	9	15.0	15.0	100.0
Total	55	100.0	100.0	

(Source: SPSS)

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Table 4: Descriptive statistics

	N	Minimum	Maximum	Mean	Std. Deviation	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
DV	55	3.00	10.00	6.7818	2.57258	-.325	.322	-1.453	.634
IV1	55	4.00	8.00	5.8182	1.57634	.577	.322	-1.435	.634
IV2	55	3.00	9.00	6.4909	2.14193	-.251	.322	-1.114	.634
IV3	55	2.00	10.00	6.8909	2.57964	-.755	.322	-.245	.634
IV4	55	5.00	8.00	7.1818	1.21854	-.935	.322	-.939	.634
Valid N (listwise)	55								

Descriptive Statistics

(Source: SPSS)

Table 5: Hypothesis 1

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.531[a]	.281	.268	2.20114	3.246

a. Predictors: (Constant), IV1
b. Dependent Variable: DV

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	100.596	1	100.596	20.763	.000[b]
	Residual	256.785	53	4.845		
	Total	357.382	54			

a. Dependent Variable: DV
b. Predictors: (Constant), IV1

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	11.820	1.145		10.325	.000
	IV1	-.866	.190	-.531	-4.557	.000

a. Dependent Variable: DV

(Source: SPSS)

Table 6: Hypothesis 2

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.625[a]	.390	.379	2.02765	3.526

a. Predictors: (Constant), IV2
b. Dependent Variable: DV

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	139.480	1	139.480	33.925	.000[b]
	Residual	217.902	53	4.111		
	Total	357.382	54			

a. Dependent Variable: DV
b. Predictors: (Constant), IV2

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.911	.880		2.173	.034
	IV2	.750	.129	.625	5.825	.000

a. Dependent Variable: DV

(Source: SPSS)

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Table 7: Hypothesis 3

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.004[a]	.000	-.019	2.59672	2.209

a. Predictors: (Constant), IV3

b. Dependent Variable: DV

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	.005	1	.005	.001	.979[b]
	Residual	357.377	53	6.743		
	Total	357.382	54			

a. Dependent Variable: DV

b. Predictors: (Constant), IV3

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	6.807	1.007		6.761	.000
	IV3	-.004	.137	-.004	-.027	.979

a. Dependent Variable: DV

(Source: SPSS)

Table 8: Hypothesis 4

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	102.865	1	102.865	21.421	.000[b]
	Residual	254.516	53	4.802		
	Total	357.382	54			

a. Dependent Variable: DV

b. Predictors: (Constant), IV4

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.536[a]	.288	.274	2.19139	2.209

a. Predictors: (Constant), IV4

b. Dependent Variable: DV

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	14.916	1.782		8.369	.000
	IV4	-1.133	.245	-.536	-4.628	.000

a. Dependent Variable: DV

(Source: SPSS)

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Table 9: Correlations analysis

		DV	IV1	IV2	IV3	IV4
DV	Pearson Correlation	1	-.531**	.625**	-.004	-.536**
	Sig. (2-tailed)		.000	.000	.979	.000
	N	55	55	55	55	55
IV1	Pearson Correlation	-.531**	1	-.862**	-.715**	.355**
	Sig. (2-tailed)	.000		.000	.000	.008
	N	55	55	55	55	55
IV2	Pearson Correlation	.625**	-.862**	1	.673**	-.418**
	Sig. (2-tailed)	.000	.000		.000	.001
	N	55	55	55	55	55
IV3	Pearson Correlation	-.004	-.715**	.673**	1	-.241
	Sig. (2-tailed)	.979	.000	.000		.076
	N	55	55	55	55	55
IV4	Pearson Correlation	-.536**	.355**	-.418**	-.241	1
	Sig. (2-tailed)	.000	.008	.001	.076	
	N	55	55	55	55	55

**. Correlation is significant at the 0.01 level (2-tailed).

(Source: SPSS)

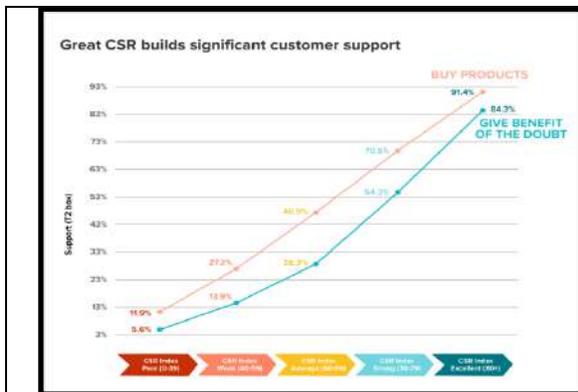**Figure 1: CSR connection to develop customer support**
(Source:Tien et al. 2020)
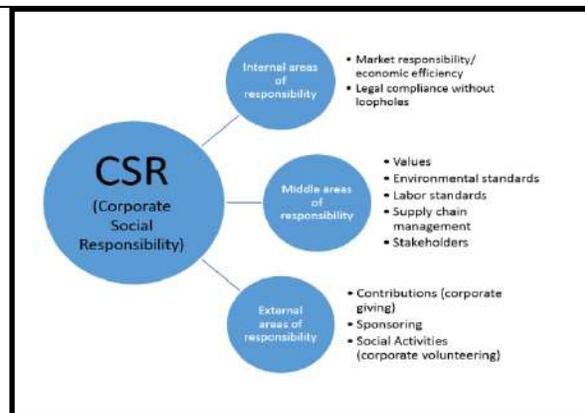
Figure 2: CSR practises in business
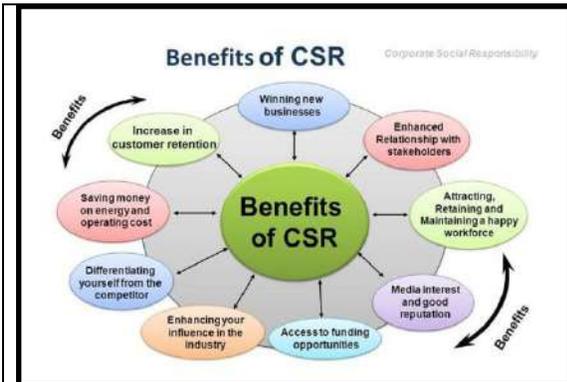**(Source: Influenced by, Ferrell et al. 2019)**

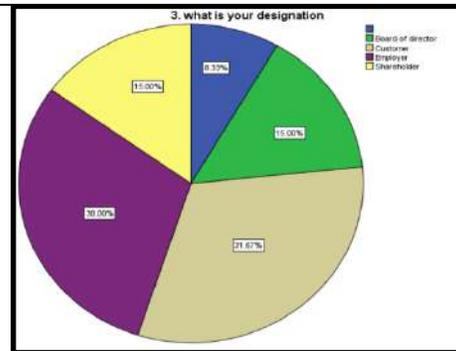|	
Figure 3: Benefits of CSR to organisation (Source: Ashrafi et al. 2020)	**Figure 4: Gender (Source: PSS)**
Figure 5: Age (Source: SPSS)	**Figure 6: Designation (Source: PSS)**
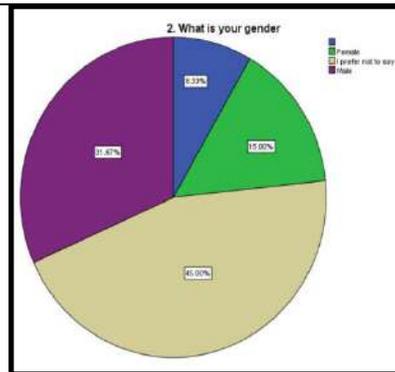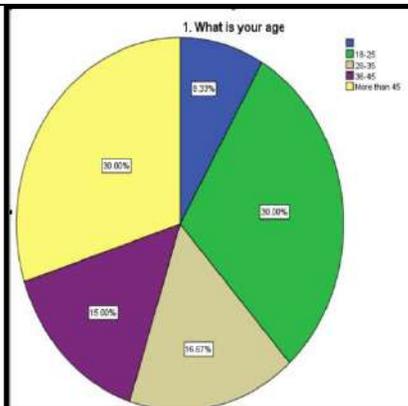
REVIEW ARTICLE

The Science of Emotions: an Understanding about its Nature and Components

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ABSTRACT

Emotions are crucial in determining how people feel, act, and generally how they are. It is essential to comprehend the nature and components of emotions for both scientific study and real-world applications in a variety of disciplines, including psychology, neurology, and social sciences. The definition, intent, and underlying physiological mechanisms that underlie emotions are all part of their essence. Emotions can be broadly characterized via complex psychological and physical states brought on by particular stimuli, occasions, or cognitive evaluations. They act as adaptive reactions that assist people in navigating their surroundings and taking advantage of opportunities or obstacles. Numerous physiological changes, such as variations in heart rate, hormonal action, facial expressions, and cerebral activity patterns, are linked to emotions. The article offers an abstract overview of the science of emotions, emphasizing essential components of its nature and composition.

Keywords: Emotion, Positive and Negative emotions, Subjective experience, Physiological response, Basic and complex emotions

INTRODUCTION

Our daily experiences are greatly influenced by our emotions, which also influence the way we think, act, and interact with others. They can be triggered by a variety of stimuli, including events, ideas, or bodily sensations, and can be strong or subtle, pleasant or negative. Joy, love, and happiness are examples of positive emotions that are generally pleasant and improve our overall wellbeing. They can improve our interpersonal interactions, spark our creativity, and foster a sense of pleasure and fulfilment. Negative emotions, such as sadness, anger, and fear, are

often seen as less pleasant but they also have significant purposes. They warn us of potential dangers, assist us in establishing limits, and inspire us to act and bring about changes in our lives. However, persistent or excessively negative emotions can harm both our physical and mental health. Studying emotional psychology allows researchers to examine why people respond to certain stimuli in particular ways and how those emotions affect us both physically and cognitively. Although the field of emotional psychology is large and complex, much has been learned about the nature of emotions and how they are expressed via our behaviour and physique. According to the American Psychological Association (APA), emotion is defined as "a complex reaction pattern, involving experiential, behavioural and physiological elements." People have emotional responses to situations or worry that are important to them personally. Individuals may have diverse emotional temperaments and varying levels of emotional sensitivity and emotional control. Positive emotions may come more naturally to some people than negative ones, while negative emotions may come more easily to others. These unique variations must be recognized and accepted.

An appraisal—an evaluative evaluation of the situation's characteristics—usually occurs before the start of an emotional episode (Lazarus, 1991). An emotional evaluation determines if a particular event or item has had a major good or negative impact on a person's objectives, values, or concerns. Many theorists have suggested that emotions have a cognitive component due to the existence of appraisals (e.g. Solomon, 1976). The way a situation is perceived and handled influences how an emotion changes over time. In a more general sense, The emotional event may persist until a significant change in perception of the event occurs. (Frijda, Mesquita, Sonnemans, & Van Goozen, 1991). An emotional state stops in a more constrained sense when shifts attention to something else. Three things make to an emotional experience: the subjective experience, the physiological reaction, and the behavioural or expressive reaction. When it comes to how emotions are elicited, Ekma(1984) has claimed that both quick "automatic appraisals" of prototype situations and more cognitively complicated "extended appraisals" of non-prototypical events can trigger basic emotions. The majority of theorists in the basic emotion tradition also concur that one element of emotions is a distinctive feeling with informative and motivating qualities. Invoking from an emotional event are feelings. This falls under the same category as hunger or pain because the experiencer is aware of it. A feeling is generated by an emotion and may be influenced by memories, opinions, and other factors.

The building up of the organism to act in order to achieve a certain objective in a specific situation is thought to be a key aspect of the emotion process. (Scherer & Moors, 2019; Barrett, 2006; Frijda, 2007). Emotions provide the person insight into the event that triggered the emotion as well as possible actions to do in order to accomplish a particular objective. If the emotion processes become conscious, they may be classified using the integrated, linguistically-based, culturally-specific emotion categories (Scherer & Moors, 2019; Frijda, 2009;). In this regard, it has been claimed that people differ in the complexity of their emotional experiences, which is another term for how people become aware of the makeup of their emotions (Grossmann, Ellsworth,Huynh, &2016; Lindquist & Barrett, 2010). It is possible to study emotion in terms of biology, cognition, and social context. The choice of measures is one of many significant components of research that are influenced by the level of analysis. On a biological level, emotions are quantified by changes in the peripheral body (such sweaty palms and tense muscles) and nervous system activity. On the level of cognition, Indications include people's perceptions of what they believe caused an occurrence, their assumptions that a specific course of action would produce a specific result, or their focus on or away from specific categories of stimuli. The amount of time people spends looking each other in the eyes, adjustments in how people are viewed, or alterations in relationships could all be considered social indicators. However, in general, it is believed that emotions play a variety of important roles. They can be seen as the biological equivalent of the body getting ready for behaviours that are often adaptive under the circumstances that give rise to the emotion (Frijda, 1986).

At the cognitive level of analysis, the theory of Oatley & Johnson-Laird (1987)uncovers significance that how emotions alter a person's priorities, assisting in the allocation of limited resources among multiple plans and objectives.At the social level, the roles of emotions have been studied in groups as small as an interaction duo (Fridlund, 1994), communication of social intents and as large as an entire culture ,expression and reinforcement of cultural values and social structures(Lutz, 1988).

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The Process of Emotion
It is generally accepted that emotions consist of three components: subjective experiences, physiological reactions, and behavioural reactions. Let's examine each of these elements in more detail. The emotional process provides the understanding about the existing events and the upcoming outcomes based on experienced emotions.

Subjective Experiences
In terms of emotion, the term "subjective experience" refers to the unique and individualized component of our emotional moods. It includes our individual viewpoints, thoughts, and prior experiences as they relate to how we perceive, interpret, and experience emotions. While the physiological and cognitive aspects of emotions can be examined and measured objectively, an individual's subjective experience of an emotion will always be unique. Despite the fact that everyone expresses basic emotions regardless of country or background, the experiences that give rise to them might vary greatly. No matter how intense the incident is, it might cause one individual to feel a wide variety of emotions, and each person will likely feel these emotions differently. For instance, one person may experience intense sadness over the passing of a loved one, while another person may experience anger and regret. Using the categories of pleasant/unpleasant and low/high intensity, another psychodynamic approach analyses emotions (Ekman 2016; Harmon-Jones et al. 2016). Emotions are described in terms of valence, which refers to the random feelings of pleasure or discomfort, and arousal, which describes the random condition of feeling either activated or deactivated (Feldman Barrett 1998). Subjective emotional experiences are extremely important in influencing a person's thoughts, behaviours, and general well-being. They are vital to understanding human psychology and behaviour as well as being fundamental elements of human consciousness. Due to the subjective nature of emotions, it is crucial to acknowledge and accept the many ways that different people perceive and express their emotions.

Physiological Responses
This physiological response is triggered on by the autonomic nervous system's response to the emotion we are feeling. The autonomic nervous system, which also controls our unpredictable physical responses, controls our fight-or-flight response.Many psychologists suggest that because of our physiological responses, emotion has probably contributed to human evolution and survival throughout history. Sympathetic and parasympathetic branches make up this system, which are typically linked to activation and relaxation, respectively. The ANS is a general-purpose system, thus its activity spans a wide range of other processes relating to digestion, homeostasis, diligence, focused attention, and other things as well (Berntson & Cacioppo, 2000) along with function of emotional responding. The combined results of several ANS measurements may suggest a higher level of autonomic sensitivity even while individual ANS measures seem responsive to dimensions rather than distinct emotional states (Cacioppo et al., 2000; Stemmler, 2004).

Here are some common physiological responses associated with emotions:
Heart rate: Heart rate might change according to emotions. For instance, the sympathetic branch of the ANS activates during feelings of fear or excitement, increasing heart rate. The parasympathetic branch, on the other hand, predominates during relaxation or contentment, resulting in a reduction in heart rate.

Blood pressure: Blood pressure can be affected by emotional arousal. Stress hormones and the sympathetic nervous system are released during strong emotions like anger or fear, which can temporarily raise blood pressure. Positive feelings and relaxation techniques, on the other hand, can assist lower blood pressure.

Facial expressions: When we are feeling something, our face muscles respond, and various emotions can be communicated through various facial expressions. For instance, a smile is frequently associated with enjoyment, whereas brows may be furrowed and the jaw may be clenched in anger.

Sweating: Sweating might become more intense as a result of emotional excitement. This can be seen in instances of stress, anxiety, or terror.

Breathing changes: Our breathing patterns might be affected by emotions. For instance, our breathing usually becomes shallower and faster when we are frightened or afraid. On the other hand, whether we are calm or depressed, our breathing may slow down.

Various emotions can cause certain physiological reactions, though the strength and persistence of these reactions may differ from person to person. It's crucial to remember that different emotions can evoke different physiological reactions, and that different emotions may provoke different physiological reactions. Additionally, cultural and personal shifts might have an impact on how people express and experience their emotions.

Behavioural Responses

People frequently display particular behavioural responses to different emotions, which might vary depending on social, cultural, and individual circumstances. Individuals exhibit these behavioural responses—observable behaviours and reactions—in response to their experiences with emotion. The actual expression of the feeling is the behavioural response component of the emotional response.

Depending on the person's personality and social norms, behavioural responses can take numerous forms, such as a smile, an expression of disappointment, a laugh, or a sigh. Numerous studies contend that many facial expressions, such as a frown to denote sadness, are universal; nevertheless, our behavioural responses are also influenced by societal norms and personal upbringing. Thus, emotions might be conceived of as distinct, referring to generally recognized, fundamental emotions like anger or joy that are believed to correspond to certain facial expressions (Damasio 1999; Ekman 2016). Here are some common behavioural responses associated with different emotions: Happiness/Joy, Fear, Sadness,Anger ,Surprise and Disgust. In order to identify six acted emotional behaviours (anxiety, anger, disgust, fear, happiness, and uncertainty), Gunes et al. (2005) combined the video processing of facial expression with nine upper body gestures.

It's essential to keep in mind that behavioural reactions to emotions are frequently complex and influenced by a variety of variables. Individuals may also develop the ability to control their behaviour in response to social expectations and norms. Determining emotional intelligence and establishing healthier interpersonal interactions require an understanding of the link between emotions and conduct.

Basic and Complex Emotions

In the next context, the study has explained about the basic and complex emotions. Every individual has various kinds of emotional states of mind. The body generates the emotions which can be segregated in to two parts basic emotions and complex emotions. Basic emotions are easily recognized by their facial expressions and frequently happen unconsciously. Charles Darwin was the first to propose the notion that feelings manifested in the face are universal. His theory of evolution was built around the idea that emotions and the ways in which they are expressed are both biological and evolutionary. That facial (and other) expressions are widely viewed as central to the notion of basic emotions is not an accident.According to Fridlund et al. (1987), the most distinguishing characteristic of a basic emotion is the facialexpression. Tomkins recognized nine primary emotions (which he referred to as "affect programs"): interest, enjoyment, surprise, fear, anger, distress, shame, contempt, and disgust. These, he insisted, are what the human motivating system is driven by. (Tomkins, 1962).

(Ekman, 1992) an emotional psychologist, established six basic emotions that could be read from facial expressions. They included joy, sorrow, fear, anger, surprise, and disgust. In 1999, he added exhilaration, disgust, contempt, shame, pride, satisfaction, and humour to the list.The most important of them all was a unique, universally expressed, and widely recognized facial expression. Ekman also suggested some other crucial characteristics that all (or at least, most) basic emotions reportedly possess.

The following criteria were used to derive them:
Basic emotions must originate from human instinct;When presented with the same situation, everybody can display the same basic feelings; People share the same fundamental feelings under the same language, and they must all

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express these basic emotions in the same manner. The idea that human emotions are universal to all races and civilizations served as the foundation for Ekman's basic emotion model. Although fundamental emotions can be interpreted differently depending on cultural background, basic emotions can also be combined to create complex or compound emotions.

Eight fundamental emotions were categorized into pairs of opposites by psychologist Robert Plutchik in the 1980s, including joy and sadness, anger and fear, trust and disgust, and surprise and anticipation. He has generated wheel model also known as the componential model, according to their respective intensities, the stronger emotions are located in the centre of the wheel model, while the weaker emotions are located at either end.The study of sentiment frequently makes use of these discrete emotions, which can be broadly divided into three categories of polarity (positive, negative, and neutral).

Complex emotions like grief, jealousy, or regret may not have as evident and have diverse outward manifestations**.** The definition of a complex emotion is "any emotion that is an aggregation of two or more others." The APA gives the illustration of how hate is a combination of fear, rage, and contempt. On the other hand, fundamental emotions are pure and innate. Love, shame, jealousy, gratitude, prideand concern are only a few examples of additional complex emotions. At least two separate emotions, either sequentially or simultaneously, are included in emotional complexity. A rapid transition in two or more emotional states, such as the sudden appearance of one emotion followed by another emotion, is known as a sequential or continuous state. According to certain studies (Ben-Ze'ev and Revhon, 2004; Berrios, 2019), emotional complexity is determined by an individual's level of emotional awareness. Indicators of emotional complexity, according to some researchers, include mixed feelings (Trudel-Fitzgerald et al., 2017). Studies on shame, guilt, andhumiliation have revealed that these feelings may serve to inspire behaviour that complies with ethical standards and atones for wrongdoings in the past. Shame is typically thought to centre on one's own self-worth or on being exposed to criticism from others; Contrarily, it is typically observed that guilt tends to concentrate more on specific wrongdoings and is caused more by an individual's private conscience than by exposure to the public. Humiliation and shame are related in that both are associated with public exposure, but they can be distinguished from one another in a number of ways. For example, unlike shame, humiliation is not something that one experiences in private. (Tangney & Fischer, 1995).The social functions of **envy and jealousy** might also be taken into consideration. The uncomfortable or unpleasant feeling toward a person who possesses what one himself desires but lacks is referred to as "envy". It frequently combines hatred and inferiority. When a person thinks their relationship with another person is at risk because of a rival who might replace them, they experience the emotion of jealousy.Like envy, jealousy can take many different forms, but they can all be understood as driving forces to preserve and strengthen the relationship under threat or, if that is impossible, to come to terms with its end. (Salovey ,1991).

In the experiment, Scherer (1998) demonstrates how some situations might result in multiple emotions occurring at once. Both the terms "complex emotions" and "blends of emotions" are used to describe these feelings. Some of the ways they can manifest themselves include a rapid sequence of different emotions, an overlap of emotions, a covering of one emotion by another, the repression of one emotion, or the exaggeration of one emotion. Desires can cause some complex emotions. A human is compelled by want to recreate an earlier scenario that satisfied a need and, as a result, increased their level of pleasure. The need that will be satisfied, the object of the desire, and the internal feeling make up the desire. Emotional, cognitive, and behavioural components of internalized experiences are present to fulfil the desire.(Burgstaller et al,2007) the perceived position that the individual is in and the predicted likelihood that a need or desire will be met both have an impact on how intense the complex feeling will be. The intensity of the complex emotion might also vary depending on whether the scenario that causes it was started by the person experiencing it or by another person.

CONCLUSION

Anurag Mishra

The definition of emotions is continually being developed. Scholars continue to have a variety of views on what emotions are, and preexisting beliefs are frequently challenged. Even so, there is a reliable base of knowledge to take into account when researching the topic. We can all express and control our emotions in different ways. How we experience and communicate our emotions can be influenced by cultures, societal norms, and our own experience. While some people might be more reticent or struggle to recognize and express their emotions, others may be more outgoing. Emotions are, in the end, an essential part of the human experience. They add variety and complexity to our lives even though they can be complicated and occasionally difficult. Gaining more self-awareness, resilience, and fulfilment can be attained by learning to manage and harness the power of emotions. Effectively understanding and controlling emotions is a crucial ability that can support personal development, wholesome relationships, and general wellbeing. People can better recognize, comprehend, and control their emotions with the use of strategies like mindfulness, emotional intelligence, and therapy. Psychological tests, neuroimaging methodologies, and measurements of the psychophysiology of the brain have all been used in research on the science of emotions. These studies have uncovered the crucial brain networks and areas involved in the neurological mechanisms underlying emotional processing. Additionally, improvements in computational modelling have shed light on the dynamic interactions between many emotional components, revealing the complexity of emotions. The science of emotions has important ramifications in a variety of fields. It provides understanding into emotional diseases, techniques for regulating emotions, and therapeutic approaches in psychology and mental health. It contributes to social science research on interpersonal interactions, social bonding, and empathy. It aids in the separation of the complex relationships between emotion, perceptions, focus, and memory in cognitive neuroscience. In summary, the study of emotions offers a multifaceted framework for comprehending the origins and elements of human emotions. Researchers and practitioners obtain a greater understanding of the underlying mechanisms, functions, and impacts of emotions through the integration of data from psychology, neurology, and related domains, which leads to a more thorough understanding of human behaviour and wellbeing.

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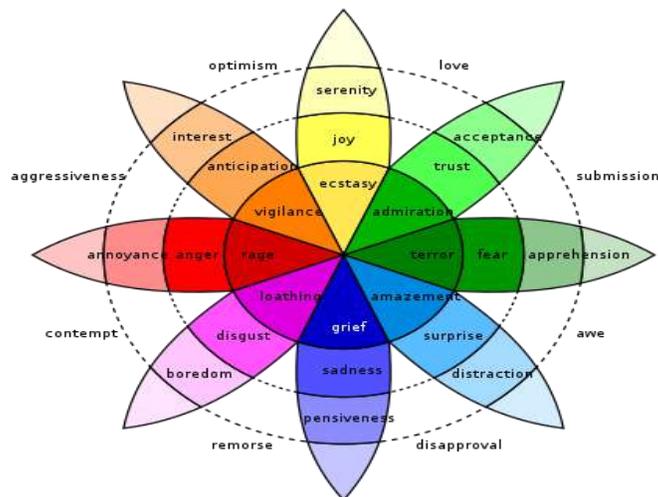
Fig. 1. Componential models (Plutchik's emotional wheel model)

RESEARCH ARTICLE

The Importance of Emotional Intelligence and Its Connections to Individual Success, Team Efficiency, Leadership Efficiency and Marketing Efficiency

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ABSTRACT

The essential point of this survey is to investigate the noteworthiness and pertinence of passionate insights in directing and upgrading one`s conduct and execution both inside and in a proficient setting. A speedy survey of the writing is conducted to decide the relative noteworthiness of passionate insights strategies to gage enthusiastic insights and the associations between enthusiastic insights and personal execution group viability administration and showcasing that most successfully coordinate one`s movement towards individual and authoritative growth. All the criteria are found to have a great relationship with passionate insights which may be a key perspective in dissecting changing and coordinating conduct towards individual and authoritative progress. Measuring passionate insights is challenging since it is hazy in case it comes from a person`s nature or by means of procured information and experience. Future investigate ought to concentrate on constructing superior observational models that take into consideration all the vital characteristics that enthusiastic insights has in arrange to have an in-depth information of its viewpoint indeed in spite of the fact that there are numerous conceptual and a modest bunch observational confirmation accessible to best back passionate insights.

Keywords: Group victory, passionate insights(Emotional Intelligence) and relationship marketing, job Fulfillment.

INTRODUCTION

Feeling could be a complicated psycho physiological encounter of a person`s mental state and his association with inner or biochemical and outside or natural powers. Feeling in individuals is fundamentally characterised by "physiological excitement expressive practices and cognizant encounter." Feeling may be connected to a assortment of distinctive variables such as a person`s identity temperament personality etc. The space of cognitive capacity known as enthusiastic insights (EI) incorporates identity characteristics and social capacities that bolster interpersonal conduct. A common definition of insights is the capacity to lock in goal-oriented versatile conduct and passionate insights. The approaches or actions, or even the succession of activities, that an employee must engage in to accomplish goals related to his employment are referred to as that employee's performance. It may also be used as a tool to determine whether or not a certain employee is meeting the goals set forth by his or her superiors and used as a way to review and assess performance. The achievements can be assessed based on effectiveness, quality, meeting deadlines, etc. (Kahtani, 2013 as a source) In most depictions, emotions take the form of enhanced decision-making abilities. The ability to recognise and distinguish one's own emotions from those of people around oneself is central to the concept of passionate insights, which can help one overcome obstacles in daily life and find solutions to problems. An individual's ability to exert leadership and achieve success within an organisation are both impacted by his level of enthusiastic insight, according to mental writing analyzers. When a person has high EI, they are better able to help the group reach its goals in a timely manner. Passionate insights, according to Ajay Goyal (2007), are an intangible quality that improves the gap between an individual's performance and his success in a team setting. In the past, associations would gauge an employee's memory and problem-solving skills, and then link those aptitudes to how well they ran errands. This method was called cognitive insights. Both Gardner and Sternberg fought tooth and nail to get conceptual frameworks put in place to make sense of findings. They laid the groundwork for the creation of the innovative and crucial marvels of passionate intelligence with their theories of interpersonal and intrapersonal insights. Meanwhile, in 1990, Salovey and Mayer successfully used logical tools to analyse and operationalize the most promising idea of eager insights (EI). A mechanism that coordinates the thinking and feeling brain forms is what Salovey and Mayer say creates passionate discoveries. Part one of this theory concerns the extent to which people can learn to regulate their emotions, and part two concerns the extent to which emotions can be managed rationally. It has the ability to understand and manage emotional responses (Mayer & Salovey 2000). He posits that joyful shrewdness imparts four crucial abilities:

1.   Detecting and perceiving feelings;
2.   Utilizing feelings to empower thought;
3.   Enthusiastic proficiency;
4.   Passionate administration.

Positive relationships exist between EI and commitment to one's work , work fulfilment completion of errands and commitment to authoritative adequacy. Palmer et al. (2002) found that people with enthusiastic competence tend to specific a tall level of fulfilment with their lives. Arrangements will without a doubt be affected in support of an association by those who can control and coordinate their feelings scholarly people.

Instead of evaluating an employee's performance based on his prior accomplishments rather than his ability to overcome future challenges, EI is now used as a valid metric to identify the top performers inside the organisation who have higher execution standards than their colleagues. Emotional intelligence tests are able to detect and record not only one's own but also other people's emotions (Goleman 1998; Mayer and Salovey 1997).It speeds up gather execution participation and cooperation. Star company execution and officials positioned EI over other qualities counting sorting out arranging and monetary and advertise investigate (trade wire 2004). Gabriele (2013) found the connect between the four enthusiastic competences and looked into how they associated to perspectives related to work-related wellbeing. The four passionate competency factors were built into a show called the Authoritative Passionate Insights Survey (ORG-EIQ) which was utilized to perform this consider on 1506 representatives from 20 diverse associations. Exploratory calculate examination (EFA) and corroborative calculate investigation (CFA) are utilized to dissect the EI structure that the association has proposed. The same strategy is utilized to explore angles

related to wellbeing as well as life adjust and temperament. The connect between the two factors is decided by relationship coefficients. Whereas the fit of the show is tried utilizing fit records the auxiliary show is examined utilizing auxiliary condition displaying (SEM). The legitimacy of amassed EI at the hierarchical level is examined utilizing the intraclass relationship coefficient (ICC). Analysing the varieties in EI among the diverse associations taken into thought utilizing ANOVA is one strategy. The four enthusiastic aptitudes were appeared to be successively related by ORG-EIQ and to have merged legitimacy with the hypothetical ideas.

The most successful and efficient performance in the organisation, according to many experts, is a leader with excellent emotional intelligence. Stronger emotional intelligence was linked by Schutte and his team to happier moods and higher self-esteem. Emotionally intelligent persons tend to have a negative link with job stress, according to Petrides and Furnham's (2006) findings that this trait is gender specific. Cary Cherniss inspected a number of vital issues that help directors' senior specialists and bosses in understanding the esteem that EI ought to have in an association. Agreeing to his case investigation people with high EI essentially outflanked their peers in a assortment of areas counting the US Discuss Drive Counselling firms' refreshments the retail division and fabricating stores which is able without a doubt be invaluable and bolster the success of the association. Enthusiastic Remainder Stock (EQI) a degree of EI that can be moved forward through preparing and learning recognises competent representatives within the association and is presently broadly utilized by numerous associations to assess an candidate. Traditional Intelligence Quotient (IQ) is a measure of workers' proficiency in the company, but it is not particularly useful for determining the efficiency of individual tasks and remains relatively constant over time. Passionate insights (EI) may help promote social states of mind and ethical behaviour, according to Goleman and Emmerling (2003), who studied the connection between EI and corporate morals.

According to Bar-on (1997), emotional intelligence is also known as emotional competence since it includes elements related to motivation, affective dispositions, and personal, emotional, and social skills. EI is seen as a crucial enhancer for the successful promotion of organisational growth by Aahkanasy and Daus (2005). The relationship between enthusiastic insights and applications in healthcare organisation was assist inspected by first year recruit and Rubino (2002) in their think about on the subject. The five centre ranges of enthusiastic insights are self-mindfulness, social mindfulness, self-direction, social abilities, and self-inspiration. These where investigated based on earlier inquire about on the positive relationship between social and enthusiastic insights over errand execution. The elements that make up EI are what give it its beauty. It examines an employee's interpersonal and intrapersonal abilities as well as his capacity to deal with stress from both his personal life and his profession. Self-awareness is under the intrapersonal skill category, social awareness falls under interpersonal skill, while self-inspiration and self-control deal with managing stress and dealing with one's own feelings about one's profession. Not as it were can a manager's abilities help in successful administration, but too his or her passionate insights features a noteworthy affect on the project's result (Morris and Feldman, 1996; Goleman, 2001; Bass, 2002). Fulmer and Barry (2004) described how emotional intelligence, in conjunction with cognitive abilities, influences the extent to which a negotiator gathers information and uses that information to draw conclusions. Decisions, situations, and answers based on both situational elements and face-to-face contacts can be better handled and managed in this way. Moon points out that EQ and cultural intelligence are strongly related concepts (CQ). Although emotional intelligence (EQ) and cognitive intelligence (CQ) are distinct, there is a correlation between some EQ traits and CQ variables. Emotionally intelligent people, according to Wong and Law (2002), are better at managing their own emotions, reading and responding to the emotions of others, and enhancing their own and others' performance at work.

Despite the fact that managers and employees are participating in several EI programmes to enhance their job happiness and performance, there is still a lack of scientific support supporting the positive effects of emotional intelligence on the workplace. The issue that emotional intelligence researchers encounter is its unreliability. Davis et al. (1998) said in their study's conclusion that "as currently posited, nothing survives of EQ that is distinctive and psychometrically sound. So, while objective EQ measures have poor reliability, questionnaire assessments are too closely tied to recognised personality traits. Emotional intelligence, however, continues to be a productive performer

in the workplace, looking at individuals from a new angle, evaluating, motivating, modifying, and directing their actions and behaviour in a way that supports organisational performance.

Methods of Emotional Intelligence Assessment

Emotional intelligence tests abound, but scientific evidence supports the validity of just a handful. Emotional intelligence tests typically involve administering a questionnaire or setting up an interview. But, differences between subgroups and the method of administration (paper, electronic, or postal) should be considered to guarantee validity. The approach's flaw is the rising cost of administration and development. Common methods for gauging emotional intelligence include ability-based exams and comprehensive integrative examinations. Commonly used measures of emotional intelligence include the Mayer-Salovey-Caruso-Emotional Intelligence (MSCEI) test, which measures the following four concepts: perceiving emotions through pictures and faces, understanding emotions through mixes and changes, fostering thoughts through facilitations and sensations, and managing emotions through feelings administration and relationships. The methodology for this test was the multi-factor Enthusiastic insights scale (MEIS). Passionate insights (EI) are evaluated on the 141-item MSCEI exam with two scores: 15 required scores and 3 optional scores. Under key MSCEIT, one learns to manage their emotions, whereas under experiential MSCEIT, one encounters feelings and uses them to promote cognition.

A crossover demonstration that assesses propensity based on four concepts—self-mindfulness, social mindfulness, self-administration, and social abilities—the 117-question Hay-group Passionate Competency Inventory (ECI) was created by Daniel Goleman and Richard Boyatzis. It generates a 20-page report that is more difficult to analyse and understand than the MSCEIT exam. A 133-item assessment of employees' interpersonal, intrapersonal, adaptability, stress management, and general mood abilities, the Emotional Quotient Inventory (EQI) was developed by Reuven Bar-On (Bar On, 2004). A 133-item assessment of employees' interpersonal, intrapersonal, adaptability, stress management, and general mood abilities, the Emotional Quotient Inventory (EQI) was developed by Reuven Bar-On (Bar On, 2004). Cognitive behavioural restricting technology is utilised in coaching to monitor improvements and changes in behaviour. Passionate self-mindfulness, passionate expression, passionate thinking, passionate self-administration, passionate administration of others, and passionate self-control are the seven dimensions that this technology uses to measure behavioural changes and improvements.

Individual Success and Emotional Intelligence

The connection between deeply felt insights and individuals' psychological health was discovered by Carmeli (2009). In order to carry out this think, a sample of randomly selected respondents from various associations is contacted through study that is executed at different periods. A central bunch is formed with a limited number of responders to advance the instrument. The creators set out to create something using emotional intelligence as the independent variable and psychological health as the dependent one. While this study does not account for cultural differences, it does find a favourable correlation between emotional intelligence and psychological well-being, which significantly influenced the latter. Timothy (2006) sought to identify the factors influencing the emergence of problems in highly regulated organisations by gauging the emotional intelligence of those involved. Observation is the key to measuring stakeholders' emotional intelligence in different industries. Stakeholders have different levels of influence and authority when it comes to managing problems and resolving labour disputes depending on the various industries in which they operate. Those involved would handle the situation far more effectively if they have a high level of emotional intelligence (EI).

There is an obvious inverse relationship between Emotional Intelligence and societal success. Nikolaou investigated the relationship between Emotional Intelligence (EI), biographical traits, occupational stress, and organisational commitment (2002). It also stresses the ways in which certain aspects of the workplace influence EI levels. One hundred twelve mental health professionals, the vast majority of whom are married women with bachelor's degrees, with an average age of 36.14 years and a standard deviation of 7.76, were recruited for this study. They were asked to rate on a 5-point scale, with a '5' representing strongly representative and a '1' not representing, in order to test different aspects of emotional intelligence and the use of emotional intelligence on problem solving. They were given

91 self-report questionnaires based on Mayer's theoretical model. An improved version of the Occupational Stress Indicator (OSI), the ASSET model can quantify stress in the workplace since it can identify both the sources and the consequences of stress. A two-point scale measuring the organization's commitment to the employee (COE) and the employee's commitment to the organisation (EOC) forms the basis of the overall Job Stress Index (CEO). The study's variables are all correlated using the Pearson correlation coefficient. To find out how different types of labour affect EI and occupational stress, we use analysis of variance. To find out how effective EI and organisational commitment are as predictors of occupational stress, hierarchical regression analysis is used. While there was no significant difference in total EI score or occupational stress across the sexes, professionals with higher EI scores tended to be more committed to their organisations and experience less stress on the job. Attempting to ascertain whether there are any discernible variations in the unproductive conduct exhibited by people with diverse emotional intelligence patterns, Satish P. (2005) focused on persons from China. The 116 participants in this study filled out a questionnaire that included numerous negative behaviours ranked on a 5-point Likert scale. Statistical methods such as t-tests and the alpha coefficient are used to evaluate its validity. Recent research has shown that emotional intelligence plays a role in the development of counterproductive habits.

However, people with different patterns of emotional intelligence do not differ significantly in their generally unproductive behaviours. Using the school board adequacy show, which is the best indicator of school board authority, Margaret M. Hopkins (2007) examined the relationship between enthusiastic insights and board administration tools through a survey that aims to distinguish the event and impact of enthusiastic insights competencies in authority and decision-making forms. Board administration spaces, as identified by Boyatzis et al. (2002) and Smoley (1999) as having 18 enthusiastic insights competencies based on the Enthusiastic Competency Inventory (ECI), are showcased here. The six basic categories of spaces are as follows: decision-making, gathering, forcing specialists, community connection, working to progress within the school board, and vital activity. There were six domains where six of the eighteen competences were determined to be common. This study highlights the significance of regularly giving board members with training to improve their emotional intelligence competency. This will help them make better judgments and develop their leadership abilities.

There was a considerable disparity between the sexes on the emotional intelligence exam. Women had much greater emotional intelligence compared to men with college degrees. Training and development programmes can refer to Elizabeth's (2002) empirical study of emotional intelligence's function in MBA performance evaluations. The 295 students that take the Emotional Quotient (EQ) test represent a wide range of ethnicities and functional areas of study, and their average age is 23.5. In addition to collecting information about students' demographics, we evaluate their academic performance based on their high school rating and Cumulative Grade Point Average (CGPA). To find out if there is a correlation between EI and a person's major, ANOVA is utilised. To investigate whether there is a correlation between EI and membership in various subgroups, a T-test is employed. Using CGPA and the five components as dependent variables in regression analysis, we can find out the relationship between EI and performance. Effective empirical assessment is made possible by condensing the scale through factor analysis.

The surveys are designed to assess validity and reliability, and to uncover their underlying reason, exploratory-factor analysis is employed. In order to carry out Confirmatory Factor Analysis, Structure Equation Modelling is employed. There were five factors taken into account, which is comparable to Goleman's dimensions. To evaluate the reliability of the model, the coefficient alpha is computed for every component.

(2019) Dr. Sapna and Bhagyshree M. Bhoir undertook a study to determine Employee Performance in Manufacturing Organizations and Emotional Intelligence are Related. Workers and employers in the manufacturing industry in Mumbai and Navi Mumbai make up the study's sample. One hundred manufacturing facility employees participated in a pilot study. Findings indicate a favourable relationship between emotional intelligence and job performance, with higher correlation values being associated with better results. Factors connected to an employee's emotional intelligence have a direct impact on their job performance, according to the cited research.

Team Efficiency and Emotional Intelligence

In 2011, Umar Ghuman developed a group emotional intelligence model. A comprehensive literature review informs an examination of two primary theories that provide the most compelling explanations for group emotional intelligence. A questionnaire has been generated and is sent to the respondents. All of the comments and suggestions are used to build a model. Its validity is confirmed by using statistical approaches. In an attempt to rectify previous manipulation flaws, they included homogeneity into the model. Building an error-free model with multiple components. Interpersonal and emotional intelligence are a part of it, and they can be utilised to connect organisational effectiveness with job performance. Having high levels of emotional intelligence both within and between teams is a part of this.

Programs for training and development are believed to be pioneers in enhancing the abilities, motivation, and skills of subordinates, which in turn improves the group's chances of success. The specialist, obligation, and justify components of these programmes should be crystal obvious. The CEO is able to sustain the group dynamics that motivate his employees to achieve the organization's goals. A manager's enthusiasm, in addition to their driving skills, is a major factor in the success or failure of a project (Morris and Feldman, 1996; Goleman,1998,2001; Bass,2002). Consistent with their personality traits, supervisors typically create a work atmosphere, as stated by Dickson et al (2001). It follows that directors who are masters of self-control can, without a doubt, motivate their teams to incredible heights. A critical understanding of the processes underlying these norms is significantly associated with team efficiency, social captiveness, and their production; Druskat and Wolff (1999, 2001) established behavioural benchmarks called enthusiastic competent bunch standards (ECGN) to demonstrate enthusiastic insights at the bunch level. The ability model of emotional intelligence (EI) and its relationship to teamwork behaviour was attempted to be investigated by Nicholas (2009). This study's sample consisted of 68 MBA students hailing from a variety of cultural backgrounds. Their average age was 30.7 and their standard deviation was 6.1. The class was randomly assigned to one of thirteen groups and given ninety-eight days to come up with a plan for a management intervention modification that would boost the organization's efficiency. Each participant took the consensus-scoring MSCEIT test of emotional intelligence before being assigned to a group to start the experiment. Respondents score their own agreement or disagreement on a 7-point Likert scale, where 1 indicates "strongly disagree" and 7 indicates "strongly agree." Eby and Dobbin's three-item subscale measure is used for the collective assessment. Each team member is asked to rate his teammate every 98 days using a 7-point Likert scale and a specially-made questionnaire that takes the team's performance into account. As a measure of the subject's cognitive ability, the participant's Grade Point Average (GPA) acts as the study's control variable. Combining the total EI and the collectivist measure, we employ regression analysis to investigate the interplay of all the factors, so avoiding multi-collinearity issues. The association between EI score and collectivism measure is identified using confirmatory factor analysis and bi-variate correlation on CPA data. Although it may not be immediately apparent, emotional intelligence did show a positive correlation with team performance. It is discovered that EI shows a clear and direct difference in the processes of transition and intermediate teams.

An important factor in improving the team's performance in the company is how subordinates perceive the leadership and intelligence of their boss. Subordinates should prioritise increasing their effectiveness and efficiency rather than getting distracted by unimportant tasks. Which, in the long run, boosts consumer happiness and loyalty while improving the company's image. This efficient measure can only be implemented when the manager-subordinate relationship is strong. While getting to know your coworkers is easy, getting to know your boss will require more effort and time. When it comes to implementing this vital practise inside his team, a manager with high emotional intelligence will do a better job than one without (Peter J. Jordan, 2010). If all goes according to plan, the business will see higher employee satisfaction and retention rates as a result of less employee turnover.

Leadership and Emotional Intelligence

An effective chief executive officer (CEO) knows the hierarchical objective, plans it out, puts it into action, and builds an activity plan that is effectively communicated to everyone in his team. Directors who are genuinely clever have a better chance of successfully managing their projects and employees. Emotional intelligence (EI) of the chief

executive officer (CEO), board of director effectiveness, and decision-making process were all linked in a study by Mohammed Ali (2012). For this study, Fern Hill and Industrial Alliance Companies administered a questionnaire to 180 Tunisian CEOs (ranging in age from 25 to 58) to assess their emotional intelligence and psychological make-up (EI). Hill and the Industrial Alliance Companies to learn more about EI and what characteristics make them tick. Leverage ratios and company size are examples of control variables. From these considerations, three empirical models are derived: To identify the subjective elements that impact a board's decision-making function, one must first BSIZE. One way to measure the size of a board is by looking at its membership. 2.BIND looks at how emotional elements relate to board independence, where board independence is defined as the percentage of independent directors relative to the total number of board members. 3. DUAL, to find out how the CEO's emotions relate to his or her dualities. Here, emotional elements such as EI and emotional bias are considered. For the third model, we use logistic binary regression to test its parameters, while for the previous two, we use linear regression to evaluate them. There is a negative correlation between the CEO's dualism and emotional intelligence and the BOD's efficiency. Boyatzis (1982) investigated the relationship between a person's emotional intelligence and their performance on two levels of stress tests: the dependent and independent levels. Workers high in emotional intelligence were also highly productive, according to the study. Emotional intelligence and its relationship to supervisory leadership performance was something that Robert Kerr attempted to investigate. To measure emotional intelligence, researchers use the Mayer Salovey Caruso Emotional Intelligence Test (MSCEIT). To analyse the results, they administer attitude surveys, which consist of nine questions. The subordinates rate each question on a 10-point Likert scale, where 1 represents strongly disagreeing and 9 represents strongly agreeing. The sample for this study consists of 1258 employees and 38 supervisors from the same organisation. The average age of the employees is 39, and the standard deviation is 0.05. Pilot tests are carried out to ensure that surveys are valid and reliable. Factor analysis is employed to ascertain the fundamental reasons behind the questionnaires developed for the purpose of assessing their reliability and validity. Factor analysis can be performed on strongly correlated data sets, according to the Kaiser-Meyer-Olkin metric. Finding the cronbach's alpha demonstrates that the surveys are consistently grouped. A Pearson correlation coefficient was used to determine the relationship between EI and how subordinates rated their supervisor's leadership abilities. They did demonstrate a positive correlation, but not to the degree expected; this shows that although EI is a major factor in predicting leadership abilities, there are many other factors that influence subordinates' perceptions of leadership's efficacy. When considering managerial EI scores during the recruiting, training, and development processes, this beneficial correlation has shown to be illuminating.

Group adequacy, enthusiastic connection to subordinates, and group effectiveness are fostered when leaders with tall passionate insights are able to effectively communicate the organization's vision and objectives to its team members. Pioneer trade enrollment and passionate insights are constructively channelled because the former entails adapting to varied social movements and introducing feelings (Liden et al.,1993). Their subordinates are motivated by their passionate connection with their supervisor, as this is viewed as an essential quality in a group leader: the ability to listen to and meet the demands of subordinates (Rahim et al, 2002). Sincere and astute managers can demand more from their employees without significantly impacting their job satisfaction or the pleasant work environment. By bringing their subordinates' interfaces in line with the association's, they can prevent project delays and quality mishaps (Barbuto and Burbach, 2006). Lopes et al. (2003) found that managers with high EI had better control over push and the kinds of problems that seemed to trigger whittling down. They can also uphold high-quality relationships.

According to Jordan et al. (2002), emotionally intelligent employees handle situations at work where one feels most threatened by their job security. The relationship between supervisors' emotional intelligence and their transformative leadership was investigated by Panagiotis (2009) when managers were selected from diverse departments and levels. To assess their perceptions of their subordinates' leadership and emotional intelligence, respectively, they were administered Multifactor leadership questionnaires and 7-point Likert scale emotional intelligence indices. Factor analysis was performed to enhance the reliability of the collected data. A favourable correlation between emotional intelligence and transformational leadership was found in the study.

A study was carried out by Fatehi (2018) in Jordanian banks to determine the impact of emotional intelligence on leadership styles, degrees of emotional intelligence, and common leadership philosophies. The study's author developed a questionnaire to gauge emotional intelligence and various leadership styles (self-awareness, self-management, social awareness, and relationship management). The study used a number of statistical methods to test its assumptions and answer its questions. Among the many important findings from the study is that social awareness is the EQ component most strongly associated with leadership style. Nawal Lazraq (2020) conducted a case study on the camp's public administration and economic sector in an effort to determine how EQ affects leadership effectiveness. To do this, they examined how each of the five EQ dimensions affected performance (internal intelligence, social intelligence, adaptability, stress management, and general mood). This objective was met by employing the descriptive analytical method. For the emotional intelligence variable, we used the Bar-On and Parker (2000) model, and for the leadership behaviour variable, we used the Thomas W. Kent (2001) model. We used multiple regression and linear correlation tests to statistically investigate the association after we had the right data. There is a strong relationship between emotional intelligence and effective leadership in both the private and public sectors, the study found. Executives need a solid grounding in emotional intelligence to build and sustain their companies' success. If they want to be successful, executives need to work on their technical and motional competencies. Given this context, a 2022 study by Larras and Kirche investigated the interplay between leadership and emotional intelligence, as well as their effects on the efficiency of the HENKEL foundation in Algeria. To do this, they used a qualitative approach based on document analysis, first-hand observation, and interviews with executives. Results analysis revealed that the HENKEL Foundation's overall performance is influenced positively by the connection between emotional intelligence and leadership.

Marketing Efficiency and Emotional Intelligence

By utilising various domains of Goleman's modified model, Gladson (2009) sought to quantitatively and qualitatively analyse the impact of emotional intelligence on the success of marketing. For the purpose of this research, 108 companies out of 365 that are listed on the Nigerian stock exchange were chosen. For the 20 EQ tests, one person in charge of HR is selected as an informant, and for the 15 MARKETING-RELATED surveys, another person in charge of the marketing division is recruited. All 108 of these illustrious organisations have their headquarters in Lagos. Instruments used in this study include the Kotler and the Likert scales. On a scale from 1 (strongly disagree) to 5 (strongly agree), the former measures emotional intelligence, while the latter evaluates the efficacy of a marketing campaign. Each of the four areas of emotional intelligence has its own Cronbach alpha coefficient, which is used to evaluate the reliability of the measurements. Means with a respectable standard deviation could be retrieved. The marketing effectiveness can be measured using a preliminary exploratory factor model and confirmatory factor analysis. Principal component analysis is employed to understand the relationship between emotional intelligence and the efficacy of marketing campaigns. Multiple regressions were run to examine the results that indicated a positive correlation between the two variables.

The viewpoints of both the buyer and the vendor are taken into account in relationship marketing. Suppliers and consumers are said to work together in harmony when there is mutual trust between the two parties (Johnston, 2004). What consumers consider as enhancing their confidence in suppliers are direct communication, preparation, and a robust responsiveness from suppliers (Carr and Pearson, 1999). Researchers Troy Hefferman and colleagues looked at the correlation between managers' trust and EI levels and their financial success in 2005. For this study, 129 branch managers and 92 relationship managers from an Australian global bank took an online MSCEIT exam. Only relationship managers between the ages of 25 and 66 were asked to fill out the survey, which included questions about how trust is built. During their biannual management performance review, the organisation compiles data on managers' performance and ranks them from 1 to 5. To do a confirmatory factor analysis, structural equation modelling is employed. Despite the importance of complete trust, a considerable positive correlation was discovered between managers' financial performance and overall EI. The bank's bottom line improves as the relationship manager's EI rises. The connection between buyer and seller, which involves the exchange of value between multiple individuals, can be better understood when relationship marketing factors such as empathy, leadership, and collaboration are considered and linked. Emotional intelligence can be a powerful tool for buyers to improve their

connections with suppliers. Lillian Schumacher lays forth the fundamental steps that explain how a buyer's EI and relationship effectiveness are revealed (2009). Here, emotional intelligence serves as the independent variable, while relationship performance serves as the dependent variable. One hundred and ten suppliers and thirty-four purchasers from US-based businesses utilise the two tools. One way to gauge a buyer's emotional intelligence is with the ECI-U version, which is based on the SAQ (Self-Assessment Questionnaire) and the EAQ (External Assessment Questionnaire). Another way is with the PAQ, which is distinct from the PSAQ (Performance Self-Assessment Questionnaire) and the External Performance. There are a total of twenty questions on the PAQ, and each one uses a five-point Likert scale. There is a factor analysis of the buyer's relationship performance and emotional intelligence. There was a greater and more positive correlation between EI and relationship performance when suppliers evaluated customers' relationships rather than the buyers themselves. From the supplier's point of view, this increases the buyer's social awareness, self-management skills, and capacity to keep in touch with suppliers. This goes to show how crucial EI is for facilitating mutual understanding and productive strategic partnerships between suppliers and buyers.

CONCLUSION

The ability to monitor and understand one's own and other people's emotional states is known as emotional intelligence. The ability to handle conflicts well is directly related to one's productivity and efficiency on the job, making emotional intelligence testing essential. necessary. People that are emotionally intelligent are better able to manage their projects and their subordinates. The success or failure of a project is heavily dependent on the manager's emotional intelligence in addition to their leadership abilities. They are able to get exceptional work out of their team members without negatively impacting their job satisfaction, work performance, or the quality of the work environment. Emotional intelligence is still seen as a valued asset by organisations that value their employees, even though there is a lack of actual research to back its reliability. distinctive perspective that undeniably enhances organisational efficacy.

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RESEARCH ARTICLE

Data Set Creation and Empirical Analysis to Detect Sentiments in Tulu Text

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ABSTRACT

Social media has become an integral part of people's lives, and their social presence is highly emphasized and invested in. YouTube, which is a social media platform, allows individuals from any location worldwide to upload videos that can be viewed globally. YouTube is currently the largest video content provider globally. The objective of the current study is to identify and analyze emotions and sentiments expressed in response to Tulu YouTube videos. Tulu is a Dravidian language primarily spoken in the Dakshina Kannada and Udupi districts of Karnataka, as well as some parts of the Kasargod district of Kerala, by approximately 1.8 million people. This language primarily utilizes the Kannada script in its current usage. The study identified various video genres and analyzed over 10,000 responses. A gold standard data set was created and labeled to detect emotions and sentiments as 'positive, negative, and neutral.' Traditional learning algorithms were utilized to analyze this data set, and empirical analysis was conducted. To overcome data imbalance, a data augmentation technique was employed.

Keywords: comments, emotions and sentiment analysis, Tulu language, YouTube videos · Data set · Data augmentation · Ensemble

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INTRODUCTION

YouTube is a social media platform that enables users to share videos with viewers worldwide. It also captures users' opinions on the videos, which can be categorized as neutral, favourable, or critical. Currently, YouTube is considered the second most visited website, followed by Google. (Marcoux, 2021) (Gandini, 2018) In this research, we have annotated Youtube comments in the Tulu language, written in both English and Kannada, as a response to the various genres of Tulu videos. Tulu is a native language largely spoken in the Dakshina Kannada district of Karnataka state as well as in the northern part of the Kasargod District of Kerala by around 1.8 million people and 5 million worldwide (Kannadaguli). The other languages spoken in Dakshina Kannada include Beary, Konkani, Malayalam and Kannada. Tulu, considered as one of the five major Dravidian languages is also one of the most highly developed languages of the Dravidian family; the other four being Tamil, Kannada, Telugu and Malayalam (Shetty, 2010) . Currently, the Kannada script (Kannada lipi), is used to write Tulu and other under-resourced languages like Konkani, Coorgi and Sankethi. This study aims to understand how sentiments are expressed in a code-mixed context where multiple languages at the sentence, word and sub-word level are used by analysing the comments that are communicated in response to Tulu YouTube videos (Chakravarthi, 2019).

Research Gaps

Tulu has a lot in common with the Kannada language and some similarities with Tamil and Malayalam. There is not much research work carried out on this language as compared to other south Indian languages like Tamil, Telugu, Malayalam or Kannada. Similarly, sentiment analysis (SA) of content in other languages is available. However, there are not many studies of SA of content in Tulu or other low-resource languages (Hegde, 2022) . Hence, our study aims to contribute to the existing corpus of sentiment analysis of YouTube comments, in Tulu, to understand user opinion.

Our contributions in this research include:
1. Creating a data set that can be accessed by users of YouTube for opinions, reviews
and general understanding of products, places, businesses and entertainment.
2. Analysing the impact of data augmentation.
3. Analysing the impact of ensemble models on performance.

Related Work

The main goal of our research study is to create a data set that identifies the emotions of the users as a response to Tulu YouTube videos and detect sentiments using various baseline models. Of the few research studies that have been undertaken in the Tulu language, most of them deal with the linguistic and phonological aspects of the language (P.J., 2010). Some deal with automatic speech recognition for the Tulu language (G, 2022) and character recognition of the Tulu script (Bhat, 2021) . Social media, while being easily accessible to all simultaneously protects user identity. Users can express their ideas and opinions and give feedback without any fear or restrictions. Several studies have used YouTube comments for text-based emotion recognition (Hassan, 2016) . Similarly, there have been studies on hate and offensive speech detection in other low-resource languages like Afaan Oromoo language (Kanessa, 2021) . There are several research articles that deal with sentiment analysis of Twitter data (Gloor, 2011) , (Agarwal, 2011), social networks (Liu, 2016) , news (Balahur, 2013) , Facebook feeds (Ortigosa, 2014) and social media (Yue, 2019) .

METHODOLOGY

Sentiment analysis, which is increasingly becoming important in business and society, is the computational study of people's opinions, sentiments, emotions, and attitudes offering insights for opinion analysis and social media analysis (Liu B. , 2010) . Analysing sentiments which involves using facial expressions, voice, gestures, posture etc., is comparatively easier than trying to extract them using only comments and that too without the user context.

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Although sentiments can be assessed using emoticons as well, for this study, we used only those comments in Tulu written in either Kannada or English or code-mixed texts using both.

Data Set Creation
To construct a dataset, we watched Tulu Youtube videos based on genres like stand-up comedies, food channels, vlogs, cooking shows, comedies, short plays, movie reviews, etc. The general objective was to make this dataset accessible for various applications that may be used as a buyer guide, knowledge creation about a particular place or a restaurant, business strategy for user opinion about a particular product etc., in short, building a data corpus.

Data Collection
The YouTube Data API is used to extract data from YouTube comments, and authentication is required to access its features. An OAuth client ID is obtained for this purpose. The API is then passed links to various YouTube videos, and the comments were extracted from them.

Data Extraction
Using the YouTube Data API, the video ID, title, and comments are obtained for each video. For every comment, the video ID and comment text are extracted and saved into a CSV file.

Data Pre-Processing and Exporting
Once the CSV file was obtained, the comment text is pre-processed to eliminate any non-ASCII characters, emoticons, English words, junk characters, and Tulu alphabets, thereby obtaining raw English text. The collected text's sample is presented in Table 1

Data Annotation
After collecting the data, we annotated the data based on the comment. This task is done manually, where every comment is read, the mood is analysed, and accordingly annotated. We did not look into the grammaticality of the language as user comments are usually in code-mixed languages and mostly with emoticons. We only analysed those comments in Tulu that are written using the Kannada and English scripts. The comment was labelled as "Positive" if there were words of appreciation/regard, "Negative" if there were words which were hateful and "Neutral" if the comments had neither positive or negative words and emotions. Comments like "ಪೊರ್ಲಾತುಂಡು", "Mast porl aatund ,keep rocking jai tulu naad", "ಜೋಕ್ಲ್ ಅತಿಜಂದ್ ಕೇನುನಕ್ಲೆಗ್ ಎರ್ ಯೆಡ್ಡೆ ಬಾಯಿಂಗ್ ಬಿಗ ಪಡಿಯಾರ್ ಕುಶಿ ಆಂಡ್ ಯ್‌ಂಕ್ " (It's beautiful,It's very beautiful, keep rocking victorious Tulu naad, you shut the mouths of people asking you as to why you have not had a child yet) were considered positive. Phrases like "imber teachera marre....Eer comedy malpunen thoothina jokulu manipande kulluva claasd ??!!!...Akullala techer n comedy malpayera??...Enk ave doubt....", "ಎಂಥ ಕರ್ಮದ ಕಾಮಿಡಿ ಮಾರೆ" (What kind of a teacher is this? The children who watch these videos in which teachers are heckled, will they behave themselves in their classes? I wonder if they too will poke fun at their teachers?, What nonsense comedy is this?) were labelled as negative. Comments like "Er yet like korre pandala yankleg onje sari like korre aapini" (how many ever times you request for a 'like', we can 'like' it only once) are considered neutral.

Corpus Analysis
Initially 7,385 comments were annotated, out of which 1,700 tweets remained after pre-processing the comments. The complete statistics of the corpus is tabulated in Table 2 The distribution of labels based on the three class in the data set is represented as Table 3. As shown in the table, the data set is unbalanced with 126 instances of "Negative" class, 906 instances of "Neutral" class and 667 instances of "Positive" class.

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Baseline models

The dataset contains three columns, namely ID, comment text, and class label that describes the sentiment associated with the text. Traditional models were trained on this dataset, with further pre-processing of the comments, feature extraction, and classification using the baseline models.

Data pre-processing

Fields that are not required for computation like the ID field was dropped. The comment text data was further processed to convert to lowercase, emoticons, punctuations, links and non-ASCII text were removed. Using NLTK package, stop words have been removed. The instances were tokenized and lemmatized using the Word NetLemmatizer from NLTK stem.

Feature extraction

Extraction of features from the comments was performed using three vectorizers namely - Term Frequency-Inverse Document Frequency (TF-IDF), CountVectorizer and FastText.

- TF-IDF: It is a statistic that calculates a score by measuring the importance of a word in a document, which depends on the length of the document and the generality of the word.
- Count Vectorizer: It is a feature extraction method that is used to vectorize a text into a matrix or vector of frequencies. These frequency count represent the frequency of occurrence of a word in the text.
- Fast text: It is a free, open-source library that is used to classify text and learn word representations from the text.

Classifiers

Seven classifiers such as Decision Tree, Ada Boost Classifier, K-Nearest Neighbour, Multi-layer Perceptron, Logistic Regression, Random Forest and Support Vector Machine of the library Scikit-learn (Pedregosa, 2011) were used as the baseline classification models.

- Decision Tree (DT): The decision tree classifier builds a classification model by the construction of a decision tree. The classification involves the prediction of target values that are obtained from the decision rules formed using the features. The maximum depth of the decision tree is specified to avoid overfitting of the model. In our case , it was set to five.
- Ada Boost Classifier (ABC): AdaBoost classifier is an ensemble method that combines various weak classifiers to obtain a more accurate and strong classifier model. It is an iterative process where, at every successive iteration more importance is given to the misclassified instances by adjusting their corresponding weights. In our study, 100 estimator models with t0 random state were used as hyperparameters of the model.
- K-Nearest Neighbour (KNN): The KNN classifier is an iterative method that classifies data points based on a similarity metric. In our implementation, this similarity metric was Euclidean distance and the number of neighbours were set to three.
- Multi-layer Perceptron (MLP): The MLP classifier model consists of layers of neurons that form a neural network. This network is trained with the data and the predicted results are back propagated for error. In our implementation, the MLP model consists of layers of 100 neurons each, trained at a learning rate of 0.001 with the activation function as relu over 200 iterations.The random state was set as zero as to have same train and test data sets across different executions.
- Logistic Regression (LR): The LR model predicts the class or target label based on the calculation of probability of occurrence of an event. The target variable is modelled using a logistic function which returns the probability of the label. During implementation the random state parameter was set to zero as to have same train and test set across different executions.
- Random Forest (RF): Random Forest is a method that performs an ensemble of different decision trees that are trained on subsets of data samples drawn from the original dataset with replacement. The RF classifier was implemented with a maximum depth of the tree as two and 100 number of estimators.

- Support Vector Machine (SVM): The SVM classifier is a method used to classify data by finding a separator which is described by a hyper-plane separating the data points in the space. To enable this, data is mapped from lower dimensions to higher dimensions. The model was trained with a linear kernel (L-SVM) function of degree three, 0.025 regularization parameter. The regularization parameter is inversely proportional to the strength of regularization.

IMPLEMENTATION AND RESULTS

The feature extraction was performed using the approaches defined in subsection 3.4.2, classified using classifiers described in subsection 3.4.3 and evaluated using stratified k-fold sampling of Scikit-learn (Pedregosa, 2011) . During the validation of the model, data was split into five folds and the average weighted-average F1-Scores are tabulated in Table 4. From Table 4 , it is clear that the model with Logistic Regression classifier applied on the features extracted using TF-IDF performs well with an F1-score of 0.6768. From Table 4, the best performing models are ABC, LR and MLP. An ensemble classifier model of these models as baseline models together resulted in an F1-score of 0.7271 for TF-IDF feature extraction.

With Data Augmentation
The comments data is populated with more "Negative" and "Positive" instances to obtain a balanced dataset for a better performance. SMOTE (Synthetic Minority Oversampling Technique) was applied after the vectorization of text to balance the data. In this approach, the features are extracted (P.J., 2010) using features defined in section 3.4.2, augmented as explained in section 4.1 and classified using the baseline models defined in section 3.4. The performance in terms of F1-scores have been tabulated in Table 5. From Table 5, it is evident that applying SMOTE has improved the performance for most instances. Further, Logistic Regression with TF-IDF performs well with an F1-score of 0.7049. From Table 5, it is clear that the model with Logistic Regression classifier applied on the features extracted using TF-IDF method performs well with an F1-score of 0.7152. From Table 5, the best performing models are ABC, LR and MLP. An ensemble classifier model of these models as baseline models together resulted in an F1-score of 0.7404 for TF-IDF feature extraction. The best performing model in each case has been obtained by ensembling the best performing baseline models. In addition to ensembling, the measure/significance of improvement in performance after applying data augmentation was measured by using the Benefit Cost Ratio (BCR) of the F1-score values, which is calculated by dividing the proposed total benefit cost by the proposed total cost. If the BCR is greater than 1, then the proposed cost is said to be significant.

$$BCR\ metric_{(f1)} = \frac{F1\ score\ of\ proposed\ model\ (with\ data\ augmentation)}{F1\ score\ of\ model\ without\ data\ augmentation}$$

The BCR values calculated using the above equation is plotted in Figure 2. The Y-axis represents the BCR scores and the X-axis represents the different baseline models applied on the data. The data points show the distribution of BCR scores of each baseline model. It is evident that the improvement in performance of the baseline models with augmentation is significant since all the BCR values are greater than 1.

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Chi-Square test is a statistical test is used to understand the difference between the observed results and the expected results. The formula for chi-square is as given below where O_k is the observed value and E_k is the expected value. Chi Squared test was performed on the F1-score and accuracy of the different baseline models, compared to the best performing ensemble model as shown in Table 8 and Table 9 respectively.

F1-Score TF-IDF   Bigram

$$\tilde{\chi}^2 = \sum \frac{(O_k - E_k)^2}{E_k}$$

Error Analysis

Error Analysis provides a better understanding of the performance of the model by analysing the errors made during classification by the system. The error rates where calculated using the confusion matrix and are as shown in the Table 10.

For instance, the comment *"Heroine edde ijjiyal Arjunanne"* translated in English as *"Heroine is not good, Arjunanne"* is evidently a negative comment and is correctly classified as negative by the model. Such instances of evidently negative or positive comments are correctly classified. It is however observed that text involving multiple emotions are not classified correctly, for instance *"Orudakulu gattadakulen kevala malper but e movie nu 100 days housefull show ethundu yankluna chikkamaglur dha koppa du"* is translated as *"although the city people look down on the people of the village, we the poeple of Koppa in Chikkamaglur will make sure that this movie has a houseful theatrical run of 100 days"* Here the first half of the comment reveals a different emotion from the second half. It has been observed that the model cannot differentiate between the various nuances of the language and therefore cannot identify the correctness of the labels. Similarly, the interpretation of rhetorical questions or suggestions also differs from one person to another and with respect to the context. The comment "*Brustaachara NAASAMULPULE*" which translates as *"eradicate corruption"* which in the context of the video is a request or a suggestion to put an end to this social evil cannot always be concluded as a neutral comment.

Scope for Future Work

This work can be further extended by analysing performance for deep learning models, use larger or more complex datasets or to explore other methods of data augmentation to further improve the performance.

CONCLUSIONS

Sentiment Analysis of Youtube comments by a user helps understand user opinion, emotions and sentiments. Social Media is a significant part of our lives through which people voice their opinions, views, thoughts and concerns on a public forum. Thus, we propose a data set that helps analyse user sentiments and emotions and also perform an empirical analysis on the same. An empirical analysis of baseline Machine learning Models like DT (Decision Tree), ABC (AdaBoost Classifier), KNN (K-Nearest Neighbours), MLP (Multi-Layer Perceptron), LR (Logistic Regression), RF (Random Forest) and SVC (Support Vector Classifier) was done for the evaluation of the data set. Among these, the model with Logistic Regression classifier applied on the features extracted using TF-IDF method performs well with an F1-score of 0.6768. It was observed that the ensemble model of ABC, LR and MLP baseline models has the best F1 Score of 0.7271, Data augmentation significantly improves the performance of all the baseline models with Logistic Regression classifier performing better than the other baseline models.

Data set Availability

The data used can be accessed through the given public Github repository. https://github.com/shreya1110-dev/Tulu Sentiment Data .

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Table 1: Sample youtube comments

Video ID	Comment
4ZSmyeRa34U	Excellent…vaa malla malla show la umdeta dumbu daala ijji…

Table 2: Comments Data Analysis

Category	Count
Data set instances (number of instances mutually annotated)	1,700
Number of sentences	1,594
Number of words	13,680
Number of stop-words	948
Number of words other than stop-words	12,732
Number of unique words	11,883
Number of unique stop-words	93
Number of unique words other than stop-words	11,790

Table 3: Comments Data Analysis

Category	Count
Negative instances	126
Positive instances	667
Neutral instances	907

Table 4: Performance analysis of baseline models

F1-score	TF-IDF	Bigram	Trigram	Fast Text
ABC	0.6514	0.3787	0.4162	0.5045
DT	0.5885	0.3787	0.3914	0.4767
KNN	0.2321	0.2213	0.2213	0.2213
SVC	0.3709	0.3709	0.3709	0.3709
LR	0.6768	0.3929	0.5329	0.4549
MLP	0.6509	0.6509	0.6509	0.6509
RF	0.3735	0.3709	0.3709	0.3807
Ensemble	0.7271	0.7105	0.4841	0.7271

Table 5: Performance analysis of baseline models with data augmentation

F1-score	TF-IDF	Bigram	Trigram	Fast Text
ABC	0.7049	0.4013	0.4290	0.6188
DT	0.3864	0.3890	0.3956	0.4721
KNN	0.4428	0.4213	0.4214	0.4210
SVC	0.3722	0.3721	0.3723	0.3743
LR	0.7152	0.4098	0.6788	0.5466
MLP	0.7054	0.6788	0.6752	0.6744
RF	0.5971	0.3799	0.3812	0.3807
Ensemble	0.7404	0.4777	0.3062	0.7120

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Table 6: T-test values test scores F1-scores of baseline models VS Ensemble model

F1-Score	TF-IDF	Bigram	Trigram	Fast text	TF(Aug)	Big(Aug)	Tri(Aug)	Fast text(Aug)
ABC	4.59E-06	2.25E-08	1.47E-08	2.54E-06	1.81E-06	2.92E-08	5.55E-08	4.57E-07
DT	2.38E-06	9.57E-09	1.14E-10	1.74E-07	8.02E-08	1.52E-09	7.26E-11	3.86E-07
KNN	7.04E-07	1.37E-06	1.13E-06	1.02E-05	8.28E-07	1.05E-04	1.41E-07	8.00E-07
SVC	1.34E-10	7.69E-09	1.14E-10	1.34E-10	5.31E-08	1.80E-09	3.74E-08	1.39E-07
LR	5.44E-07	2.04E-9	6.31E-08	3.21E-06	2.30E-07	4.91E-06	8.58E-08	7.50E-08
MLP	4.21E-07	4.02E-9	1.86E-09	6.22E-08	3.29E-07	4.02E-06	8.61E-07	6.09E-06
RF	2.31E-09	1.34E-10	1.34E-10	1.32E-06	8.06E-06	1.06E-06	3.41E-06	1.32E-06
Ensemble	-	4.02E-02	2.33E-04	2.19E-04	3.45E-02	2.53E-04	8.61E-04	6.10E-04

Table 7: T-test scores of accuracies of baseline models vs ensemble model

Accuracy	TF-IDF	Bigram	Trigram	Fasttext	TF(Aug)	Big(Aug)	Tri(Aug)	Fasttext(Aug)
ABC	1.16E-06	2.04E-08	1.47E-08	4.14E-07	1.41E-06	2.14E-08	1.13E-08	5.36E-07
DT	2.24E-07	8.87E-10	8.13E-11	9.42E-09	1.25E-08	8.25E-10	1.25E-10	4.80E-07
KNN	3.68E-08	2.55E-08	2.48E-08	2.46E-05	7.97E-07	8.71E-05	3.41E-08	2.71E-06
SVC	1.05E-10	4.47E-10	5.95E-11	1.05E-10	3.51E-08	4.65E-06	1.64E-06	3.57E-06
LR	3.83E-08	1.32E-07	1.89E-07	8.46E-08	2.48E-08	4.13E-08	7.00E-09	6.51E-08
MLP	1.03E-08	7.60E-07	4.55E-08	1.26E-08	3.42E-08	4.13E-07	7.00E-07	6.06E-08
RF	3.29E-10	1.05E-10	1.05E-10	2.64E-08	7.57E-06	1.06E-06	5.93E-07	8.90E-07
Ensemble	-	7.60E-03	4.84E-07	1.47E-04	3.45E-02	2.53E-04	7.00E-04	5.22E-04

Table 8: Chi-square test scores of F1-scores of baseline models vs ensemble model

ABC	0.9970	0.9818	0.9598	0.9882	0.9980	0.9984	0.8517	0.9970
DT	0.9708	0.9994	0.9951	0.9999	0.8566	0.6118	0.5764	0.9796
KNN	0.7618	0.4213	0.7801	0.9998	0.9544	0.6953	0.6060	0.9808
SVC	0.7741	0.8602	0.8754	0.8002	0.8142	0.7278	0.6818	0.6287
LR	0.9995	0.0319	0.9694	0.5466	0.9999	0.9999	0.9997	0.9802
MLP	0.9999	0.0963	0.0204	0.9999	0.9999	0.9999	0.9997	0.9999
RF	0.7839	0.9515	0.9682	0.8515	0.9905	0.8038	0.7205	0.9821
Ensemble	-	0.1539	0.9951	0.9999	0.9999	0.9999	0.9997	0.9987

Table 9: Chi-square test scores of accuracy score of baseline models vs ensemble model

Accuracy	TF-IDF	Bigram	Trigram	Fasttext	TF(Aug)	Big(Aug)	Tri(Aug)	Fasttext(Aug)
ABC	0.9923	0.9975	0.9949	0.9874	0.9984	0.9011	0.8440	0.9969
DT	0.8773	0.9990	0.9997	0.9946	0.9023	0.7885	0.7739	0.9801
KNN	0.7976	0.8331	0.8530	0.9999	0.9767	0.8350	0.7868	0.9904
SVC	0.7309	0.8081	0.8335	0.9946	0.9000	0.8422	0.8247	0.7996
LR	0.9730	0.5056	0.9985	0.8288	0.9999	0.9999	0.9997	0.9814
MLP	0.9999	0.5232	0.4061	0.9986	0.9999	0.9999	0.9997	0.9982
RF	0.7350	0.9999	0.9478	0.7834	0.9900	0.8752	0.8362	0.9849
Ensemble	-	0.4765	0.9968	0.9909	0.9999	0.9999	0.9997	0.9177

Table 10: Error Rates of the classifications

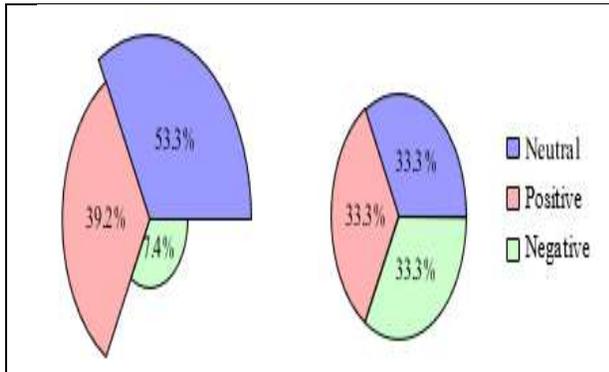| Labels	Error Rate
Over-all	0.1384
Positive	0.1305
Negative	0.1727
Neutral	0.1121

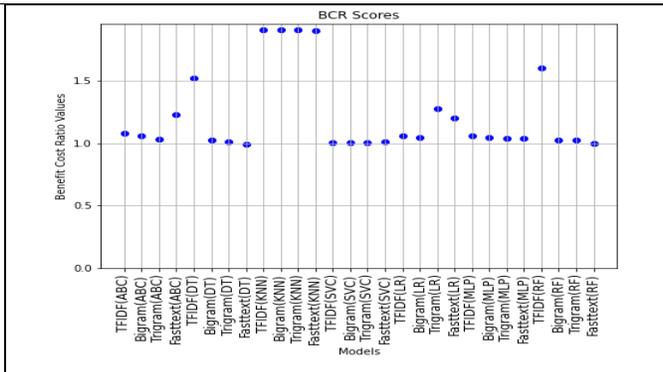**Figure 1: Analysis of the effect of data augmentation in the data(a) Before applying SMOT (b) After applying SMOTE**

Figure 2: Distribution of BCR values of F1 scores